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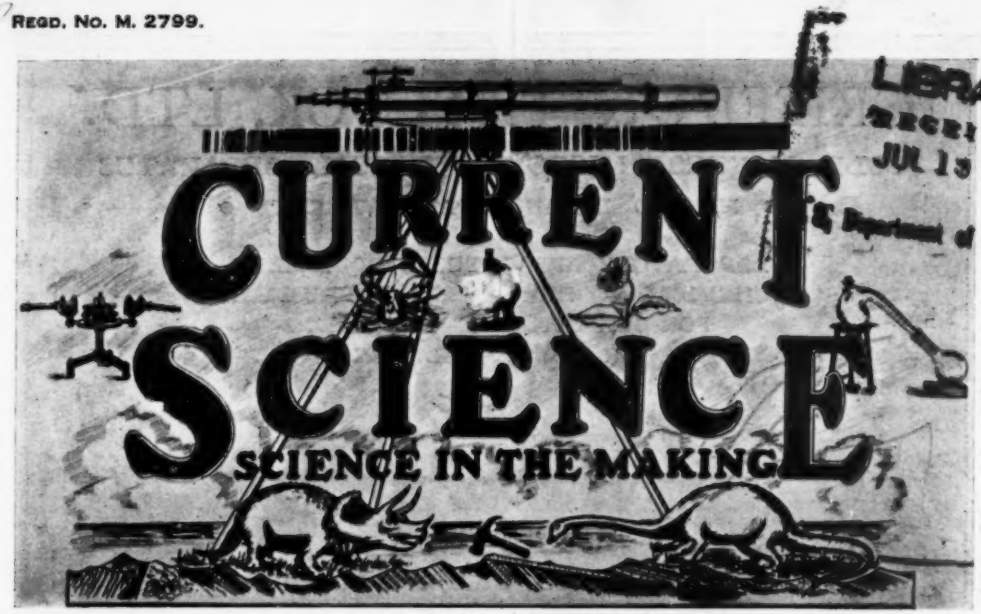




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## CONTENTS.





## The Road-Rail Conference.

THE recent discussions at Simla on the road-rail controversy have proceeded on the assumption that man is still rooted to the earth. Within the last quarter of a century he has succeeded in achieving a three-dimensional existence. The problems which confronted the Conference need not have been attended with the degree of acrimony which the lack of imagination in the bureaucratic mind about the trend of modern transport service has engendered. The whole discussion in the Conference bore an air of unreality, for in none of the speeches could one discover the realization of the fact that in a rapidly moving age of scientific discoveries and inventions no industrial or commercial concern, however strongly entrenched behind official support, can hope to enjoy protection indefinitely, unless it can visualise future developments and possess sufficient elasticity and power of adaptation.

The ostensible object of the Conference, as can be made out from the published speeches, is to discover the means of rendering the competition between the two systems of transport less wasteful, if not more profitable. This can be achieved only by making one of the services complemental or tributary to the other. A proposal of this character will naturally place the fields of operation by the road and rail system tangential and not parallel to each other. The consideration whether the bus service when restricted to the areas to be opened by the provincial schemes of road development, will continue to be a paying concern, has not fallen within the purview of the Conference. It is true that the security of railway service may be temporarily purchased by converting automobiles into subordinate feeders; and for this purpose the Government of India is prepared to raise a loan for launching an extensive scheme of road development in areas not served by railways. The mere construction of roads linking the isolated parts of the country with the more advanced distributing centres, does not offer hopes of promoting the social and economic prosperity of the rural population and when conditions of development such as irrigation projects, power service, organization of labour, modern scientific methods of cultivation and popularisation of subsidiary occupation are not simultaneously

introduced, the proposed costly roads are bound to remain ornamental failures.

According to Sir George Schuster, there are two favourable conditions at the present moment for raising a public loan in order to finance the provincial governments which are invited to adopt the doctrine that, "the main need on which the country should concentrate during the next phase of development is to develop the road system so as to bring that into balance with the railway system and provide a better circulation of traffic to railways." One of these conditions is that money is available at a cheap rate of interest rendering capital expenditure economically justifiable. The second condition is that the Government of India is not committed to any extensive capital expenditure and can therefore embark on the road development plan with cheaply available money. It is proposed to place the necessary funds at the disposal of the local governments, as soon as they produce schemes providing for the service of loans, the maintenance of roads and proofs of their economic productivity.

While we generally approve of the stipulations of the central government contrived to meet specific circumstances, we are not quite convinced of the economic expediency of incurring heavy public debts which add to the financial burden already none too light. Public credit like the giant's strength, is excellent to possess but grievous to use. One of the main objections to the loan policy of the government is that the exhaustion of public resources by offering attractive methods of investment, will result in a proportionate contraction of the capital for industrial development through private enterprise. It seems to us that for other and more serious reasons the present moment seems to be singularly inopportune for raising large sums of money from the public. With prevailing rates of low prices for the produce of the land, agriculture will remain for some time unhonoured. The sad spectacle of industrial collapse, such as is witnessed in Bombay, is sure to chill the ardour of the most enterprising capitalists for establishing new manufacturing concerns. To overstrain the public resources on the eve of momentous constitutional changes is a step likely to impose serious handicaps on the new Government. Above all, loans must necessarily produce serious repercussions on public revenues resulting in extensive curtailment of subsidies for consolidating and inaugurating schemes of moral and material advancement. But what is the solution for the acute competition of the dual transport systems in which the government and the country are equally involved?

We agree that the suggestion of the central government for an extensive scheme of road development may be expected to provide at least temporary relief; but we are not charmed with the methods proposed by them to secure the end. We hold that the situation could have been avoided through the exercise of a little imagination. In normal times, the public revenue and resources of special funds, such as we had advocated in these columns some time ago, should be adequate to handle an emergency of this character. However, Sir George Schuster points out that "the justification for the construction of roads from loans rather than from revenue must be that construction from revenue would be too slow to meet the needs of the case." A rapid completion of public works need not necessarily imply immediate improvement of their taxable capacity and especially in a case like the road development, in which, the loan is intended to be applied to a single limited purpose, the economic productivity of the proposals, depending as it does on the equally important collateral projects, must be a process of slow evolution. The alternative suggestion we make of utilizing the revenue and resources of reserve fund for developmental programmes offers advantages, such as consolidation, revision, periodical tests of the works and cautious application of the funds which should characterise the administration of public finance. The acuteness of competition has been permitted to grow over a fairly long period of time without thought of its pernicious character and the hasty remedy proposed to be applied is likely to shift the malady in a worse form to some other part of the social organism. Sir Guthrie Russell points out that the main cause of the present position is not motor competition,—it is the world-wide economic depression and the loss sustained by the railways on account of competition is estimated between one and a half and two crores of rupees, and for redressing this and for stimulating the economic productivity of the rural areas through road development, a loan amounting to three times this sum is proposed to be raised.

Sir Guthrie Russell's speech is devoted to the consideration of rendering the competition fair, by imposing statutory obligations on motor service, such as those under which the railways work. Some of them, especially those which ensure the safety and convenience of passenger traffic, are necessary in the interests of the public, but to enforce them all at once in the categorical order enumerated by the Chief Commissioner of Railways would kill the automobiles. But the position of the Government is that since the railways are capable of handling any volume of passenger and goods traffic, and of providing advantages, such as the road motor services cannot for a long time contemplate, it is only reasonable to withdraw automobiles from those roads of 1300 miles which run parallel to the permanent way. In an economic controversy of this nature, it is not the interests of the competing agencies alone that are involved, but those of the public which indeed are paramount. It seems to us that, should the Conference, instead of discussing the problems of competition and the prospects of public loans, have investigated the causes of the unpopularity and unattractiveness of the rail system of transport, a great step would have been taken in the solution of a controversy which is fundamentally psychological. Travelling and circulation of goods are the essence of civilized life and this fact should not be permitted to be exploited either by competition or combines or monopolies.

Perhaps, the Hon. Mr. E. Miller's plea for the early consideration of resolution No. 8 regarding a coordinating authority, envisaged the complexities of the situation in their proper perspective and their future relations. Within a very short time the Government and the people will be confronted with the problem of providing the country with a well-articulated system of water-rail-road-air ways working on a co-operative basis. If the railways are to be preserved from becoming obsolete, the problem of gauges should engage the attention of the authorities immediately. The transfer of passengers and goods from one gauge to another entails a certain condition of affairs which, if not remedied, must ultimately render the rail service totally unpopular. It is wasteful and uneconomic to protect defects in the means of transport which in a fair field of competition, will automatically be removed. Before the Government seek to impose statutory obligations on the bus service and stop the competition between road and rail systems of transport in places served by the railways, the public, especially that section which contributes 89 per cent of the railway earnings, should receive the fullest assurance that they will be provided with a cheap, sanitary and comfortable mode of travel in third class compartments.

We said that want of scientific imagination is the root cause of all our social and economic troubles and that resolution No. 8 on the agenda of the Conference is the most important one. We cannot forget the fact that for shipment of goods and booking of passengers for less than forty miles, the bus and motor offer facilities which the railways can never hope to provide and it should be no wonder that in years to come an increasing volume of short-haul business is completely diverted to motor trucks. Besides the problem of distribution,—perhaps the most intricate problem with which the industries and transport service are confronted,—can approach a solution in the activities and success of the committee such as is contemplated in the 8th resolution.

During the last twenty-five years scientific discoveries and inventions have introduced us into a new world with a different outlook and environment. The evolution has been so rapid that readjustment has become difficult. The Government which lacks imagination to foresee the coming changes and to prepare for new adjustments will find itself in a vortex of trouble and deal with the altered conditions with crude and clumsy methods. If and when the Geneva Conference decides upon the abolition of aeroplanes for military service, the world will witness a new competition in commercial aviation which bids fair to render obsolete the existing systems of transport by land and sea. To meet this situation successfully Governments should begin to rely more and more on science to provide a suitable machinery for mutual adjustment among the competing services and if they do this, they would have laid the foundation of a lasting and orderly social structure.

## Felicitations.

THE Birthday Honours list has brought the distinction of Knighthood to two of our editorial co-operators, Dr. M. O. Forster, F.R.S. and Col. R. McCarrison, C.I.E., whom we have pleasure in felicitating. It is highly gratifying to note that scientific service is suitably recognized by His Majesty's Government in India and we hope that other eminent scientific workers in the country will be speedily and fittingly honoured.

As administrator of the Indian Institute of Science which occupies the premier position in India, for the last ten years Sir M. O. Forster has rendered invaluable services in the expansion and consolidation of the research departments under his administrative care and his wide experience and knowledge, his eminent attainments and above all, his genial and stimulating personality have been a source of inspiration and liberal education to all who have come within the range of his influence.

Sir R. McCarrison is an intrepid researcher in the science of animal nutrition,—with special reference to goitre, and the results of his scientific labours have been internationally recognized. He has been recently elected to open the International Conference on Goitre at Berne and the Knighthood conferred on him is a fitting recognition of his eminence as an investigator of the fundamental problems which affect human welfare. We wish both of our co-operators who are the recipients of distinguished honours, long life of increasing usefulness in the service of science and of the country.

## On a Connection between Di- and Triatomic Molecules.

By Dr. H. Lessheim and Dr. R. Samuel,
*Muslim University, Aligarh.*

SINCE the recent development of the theory of molecular spectra it has become clear that it is necessary to pay consideration to the fact that chemical linkage does not always arise from the ground levels of the atoms concerned. We have therefore to add a certain amount of energy of excitation to the heat of dissociation of a compound in its atoms, if it is taken from thermo-chemical data.

The carbon atom, *e.g.*, in its ground level $s^2\,p^2\,{}^3P$ is able to form a linkage with one O atom only, since the complete group of two s-electrons is chemically inert and acts repulsively; a second O atom cannot be linked from the ground level. Therefore already other authors, *e.g.*, Mecke (*Zs. f. phys. Chem.* B. **7**, 108, 1930) have tried to explain the linkage of $CO_2$ by assuming an excited C atom in the $s\,p^3\,{}^5S$ state. In a recent paper (*Zs. f. Phys*, in press) we could show that apparently an s-electron does not undergo a linkage with the p-electrons of a negative partner. So, for the second linkage of $CO_2$ we have to assume a C atom excited to the $p^4\,{}^3P$ state. This is all the more so because it is known from the chemical behaviour as well as from the infra red spectra that there is no difference between the linkages of the two O atoms.

In the case of the homologous molecule PbO we are in a position to prove this also from band spectrum data.

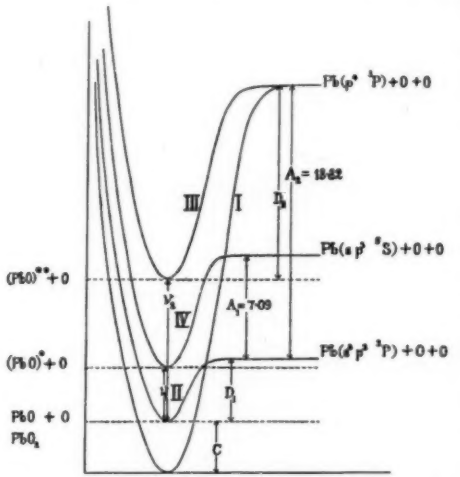
The thermochemical data are not fully known, especially our knowledge of the specific heat and of the heat of evaporation is insufficient. So the values of the molar heats of PbO and $PbO_2$ are graphically extrapolated in the range where no measurements are available, the values of the heat of evaporation are calculated by means of Trouton's Rule (Grüneisen's modification). That the data employed in the calculation are fairly correct can be taken from the fact that we found the heat of dissociation of PbO to be $D_1 = 4{\cdot}38$ volts, in best accord with the spectroscopical value $D_1 = 4{\cdot}27$ volts. Some uncertainty arises only in the case of the dissociation energy of $PbO_2$, where we had to estimate even the melting and boiling temperatures; but this does not matter because we shall soon see how to get rid of this uncertainty. We obtain provisionally

$Pb_{at} + O_{at} = PbO_{mol} + D_1$ where $D_1 = 4{\cdot}38$ volts,

$PbO_{mol} + O_{at} = PbO_{2mol} + C$ where $C = 2{\cdot}05$ volts,

$Pb_{at} + 2\,O_{at} = PbO_{2mol} + C + D_1$ where $C + D_1 = 6{\cdot}43$ volts.

Considering the system Pb+O+O, we have found now three energy levels, the lowest one being that of $PbO_2$, another one of the system PbO+O, 2·05 volts higher, and a third one of the system of the separated atoms Pb+O+O, 6·43 volts above the lowest, each consisting of atoms and molecules in their respective ground states. The terms s $p^3$ $^5S$ and $p^4$ $^3P$ of Pb require an energy of excitation of $A_1$=7·09 and $A_2$=18·82 volts respectively. Thus we get




at curves I and II of the figure. Knowing as mentioned above that the amounts of energy by which the first and second O atoms are bound are equal, we have to halve the total dissociation energy of the $PbO_2$ bond (25·25 volts) to get the minimum point of curve III at $\nu_2$=10·58 volts above the minimum point of II. This is the energy level of the system PbO+O, PbO being in that excited state in which it is able to accept the second O atom, and dissociating in Pb ($p^4$ $^3P$)+O.

These calculations, if correct, enable us to predict the energy level of the PbO molecule derivable from the Pb in the s $p^3$ $^5S$ state. The amounts of energy wanted for the excitation of the first and second s-electrons though of course different in Pb and PbO will be in almost the same ratio in either case. We divide $\nu_2$ in the proportion $A_1 : A_2$ and find the minimum point of the predicted curve IV at $\nu_1$=3·99 volts above the ground level of the PbO molecule. The dissociation energy of the molecule in this state results to about 7·5 volts.

This method of calculation applies to any molecule of this kind. We selected PbO because the predicted energy level is well known from band spectra proving the soundness of the fundamental idea. The D-bands of PbO are a $^1\Sigma-{}^1\Sigma$ transition, the upper state lying at 3·71 volts with an energy of dissociation of 8·24 volts. Considering the uncertainty of the thermochemical data employed these figures are in full agreement with the predicted ones. Besides another electronic level (III) of the PbO molecule is predicted, arising from the Pb($p^4$ $^2P$) state with the electronic transition $\nu_2$ from the ground level and the dissociation energy $D_2 = A_2 + D_1 - \nu_2 = \nu_2 + C$.

Putting the results in the form of equations we get,

$$\nu_1 = \frac{A_1}{2} + \frac{A_1}{2A_2}(D_1 - C) \qquad (1)$$

$$\nu_2 = \tfrac{1}{2}(A_2 + D_1 - C) \qquad (2)$$

$$D_2 = \tfrac{1}{2}(A_2 + D_1 + C) \qquad (3)$$

Now by means of equation (1) we can rid ourselves of the uncertainty in the thermochemical calculations and in the reverse find better values for the thermo-chemical data. Using the spectroscopical values $\nu_1$=3·71 volts, $D_1$=4·27 volts, which are more exact, and introducing them into (1), we find,

$$PbO_{mol} + O_{at} = PbO_{2mol} + 3{\cdot}39 \text{ volts},$$
$$Pb_{at} + 2O_{at} = PbO_{2mol} + 7{\cdot}66 \text{ volts},$$

Total heat of dissociation of $PbO_2$=26·48 volts,

$$\nu_2 = 9{\cdot}85 \text{ volts},$$
$$D_2 = 13{\cdot}24 \text{ volts}.$$

As to the energy of the bonds of the different electronic groups another interesting result can be obtained. We have seen now that the upper state of the D-bands of PbO comes from the Pb(s $p^3$ $^5S$) a result already got in another way in the paper mentioned above. The excitation of the molecule corresponding to the D-bands means the transition of an electron from $p\sigma$(s) in the lower state to $f\sigma$(p) in the higher one. Either group is a so-called promoted group, *i.e.*, it loses energy when the distance of the nuclei decreases. The energy of excitation $^5S-{}^3p$ of the Pb atom is higher than the corresponding energy $^1\Sigma-{}^1\Sigma$ of the PbO molecule. So the dissociation energy being higher in the upper level than in the groundmost one we can say that the promotion of the $f\sigma$(p) group cannot have started at the nuclear distance of the PbO molecule to any considerable extent or at least is much less

than that of the $p\sigma(s)$ group, for otherwise the energy of dissociation would decrease with excitation.

Thus it is evident that there exists a near connection between the energy states of a diatomic molecule and a triatomic one derived from it. It is also shown that atoms of the fourth family, *e.g.*, C, really undergo a tetravalent linkage from the $p^4\ ^3P$ term. This has to be considered in many questions of thermo-chemistry. A full report will be given elsewhere.

## Influence of Wall Effect on the Nature of Coagulation Process.

By Dr. B. N. Desai, M.Sc., Ph.D.,

*Wilson College, Bombay.*

IT has been realised by investigators in colloid chemistry that the walls of the containing vessel may affect the rate of coagulation. Desai (*Trans. Faraday Soc.*, **24**, 181, 1928; Patel and Desai, *ibid.*, **26**, **128**, 1930; Desai, *Kolloidchem. Beihefte*, **26**, 357, 1928; cf. Freundlich, Colloid and Capillary Chemistry—Eng. Translation—1926, p. 417) has discussed in detail the defects in the various methods used for following the course of coagulation which might be responsible for the observance or non-observance of the S-shaped coagulation velocity (C.V.) curves and the auto-catalytic nature of the coagulation process. In discussing the ultra-microscopic method it has been pointed out that the walls of the cell containing the colloid might have also some effect on the course of the coagulation reaction and that there is a possibility of greater percentage error with dilute sols—which alone can be used with this method—than with concentrated ones owing to the wall effect. In a concentrated sol the number of colloidal particles being comparatively larger than in a dilute sol, the effect of the walls in acting as centres for coalescence will be negligible.

In a recent paper S. S. Joshi and V. L. Narayan (Special Number of the *Journal of the Indian Chemical Society*, 1933, p. 41) have studied in detail the influence of wall area in the coagulation of colloidal solutions of $MnO_2$, $Sb_2S_3$ and (+ively charged) $Fe_2O_3$. The concentration of the disperse phase in the colloidal solutions tried by them is not very high. They have observed that the rate of coagulation is markedly increased in all cases when the wall area of the coagulating system is increased by introducing glass beads. They also find that when the same number of beads and the containing walls are paraffined, the coagulation is sensibly retarded in all cases. In the light of their results they consider unlikely that the increase in the rate of coagulation, under wall effect alone, can convert a 'slow' into a 'rapid' coagulation. They conclude that auto-catalysis cannot be considered as a general characteristic of coagulation as has been supposed by some workers, but that it is a secondary process which adds to the main course of coagulation under certain conditions.

It will not be out of place to consider in some detail the results of Joshi and Narayan in this letter as they have an important bearing on the theory of slow coagulation proposed by Freundlich (*loc. cit.*, pp. 431-447). As shown by electrosmotic, cataphoretic and stream-potentials measurements, the wall-layer of glass in contact with water becomes negatively charged. The nature of this charge will be modified considerably in the presence of electrolytes as well as when the glass surface is paraffined. It is, therefore, certain that the glass surface will help or retard the coagulation according to the nature of the charge on it and on the colloidal particles. Moreover glass walls themselves, whether paraffined or not and whether charged or uncharged, will act as centres for coalescence. In view of these considerations, it is not justifiable to say that the results of Joshi and Narayan support the conclusion that the nature of coagulation process is not intrinsically auto-catalytic.

On the other hand, their results can well be utilized to show that the nature of coagulation process is auto-catalytic. For as shown by them the walls of the containing vessel (unparaffined) make the S-shape of the C. V. curves less marked and it is quite likely that non-observance of auto-catalysis by some workers might be to a certain extent due to this effect. As shown by Desai (*loc. cit.*) the appearance of the

S-shaped C. V. curves or demonstration of the auto-catalytic nature of the coagulation process depends on the concentration of the coagulator, the purity of the sol and the concentration of the disperse phase, apart from the suitability of the method employed.

## Letters to the Editor.

### On the Radioactive $\alpha$-Emission.

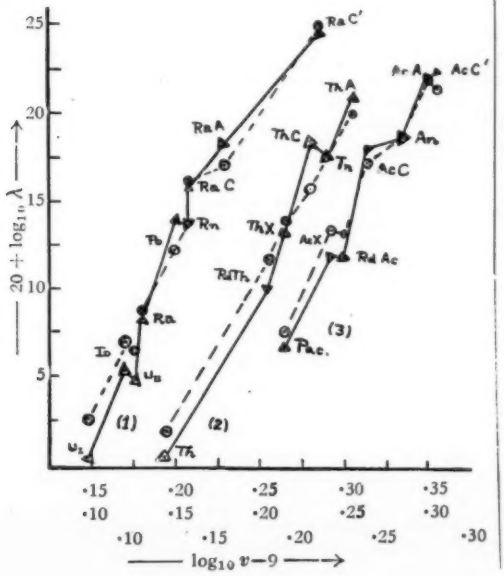
In a recent paper (*Ind. Phys. Math. Jour.*, 1932) we have derived a wave-statistical expression for the damping coefficient of the phase space. In the above paper we assumed this coefficient to be identical with the disintegration constant for the $\alpha$-particle. Later investigations of the authors, which are not yet published, show that the previous assumption is not justified. The disintegration constant is, however, related to the damping coefficient. It is shown that the constants are:

$$\lambda_{\text{damp.}} = -\frac{1}{N}\frac{dN}{dt} = \frac{\cdot 61}{h}\sqrt{U_\circ E}$$

[*cf.* Eq. (36) L.C.] .. (1)

$$\lambda_{\text{dis.}} = -\frac{1}{N_a}\cdot\frac{dN_a}{dt} \quad .. \quad .. \quad (2)$$

where N is the total number of $\alpha$-particles inside the hard core and $N_a$ the effective number present in a thin spherical shell just inside the core. It is evident that $\frac{dN}{dt} = \frac{dN_a}{dt}$.




Applying the solution to the shell and using the boundary condition one readily obtains [*vide* Eq. (24) L.C.]

$$\frac{N_a}{N} = \text{const. } \cot u_\circ\, e^{2k(2u_\circ - \sin 2u_\circ)}\, r_\circ^{\,2}\, \Delta r_\circ \quad (3)$$

Combining (1), (2) and (3) we get

$$\lambda_{\text{dis.}} = \text{const. } \frac{\sqrt{E}}{r_\circ h \cot u_\circ}\, e^{-2k(2u_\circ - \sin 2u_\circ)} \quad (4)$$

The theoretical values of $\lambda_{\text{dis.}}$ calculated from the above equation closely agree with the standard experimental values for the three families of radioactive substances. This is evident from the graphs where the curves drawn continuous give the theoretical values.

K. C. KAR.
A. GANGULI.
Physical Research Laboratory,
Presidency College, Calcutta,
*May*, 1933.

### On the Two Dimensional Statistics of Kar-Mazumdar.

In a recent paper Kar and Mazumdar (*Zeit. f. Phy.*, **55**, pp. 546–554, 1929) have obtained the distribution functions of Bose-Einstein and Fermi by generalising Gibbs' statistics. In doing so, they have introduced, over and above the free energy $\psi$ per molecule, a new class of free energy $\psi_s$ per 's' type cell. Thus, according to them, the total free energy of all the cells is

$$\sum_s A_s \psi_s = \Psi_2 \quad .. \quad .. \quad (1)$$

'$A_s$' being the total number of 's' type cells.

Now, as the extension of the old statistics is ultimately due to the structure of the phase space, $\Psi_2$ may be taken also as the additional free energy of N molecules arising out of the cells. Therefore, the total free energy is

$$\Psi = \Psi_1 + \Psi_2 \quad .. \quad .. \quad (2)$$

where $\Psi_1 = N\psi$, the classical value of the total free energy.

According to the classical statistics,

$$-\frac{d\Psi_1}{dV} = P_{(\text{mol})} = \frac{NKT}{V} \quad .. \quad .. \quad (3)$$

than that of the $p\sigma(s)$ group, for otherwise the energy of dissociation would decrease with excitation.

Thus it is evident that there exists a near connection between the energy states of a diatomic molecule and a triatomic one derived from it. It is also shown that atoms of the fourth family, *e.g.*, C, really undergo a tetravalent linkage from the $p^4\ ^3P$ term. This has to be considered in many questions of thermo-chemistry. A full report will be given elsewhere.

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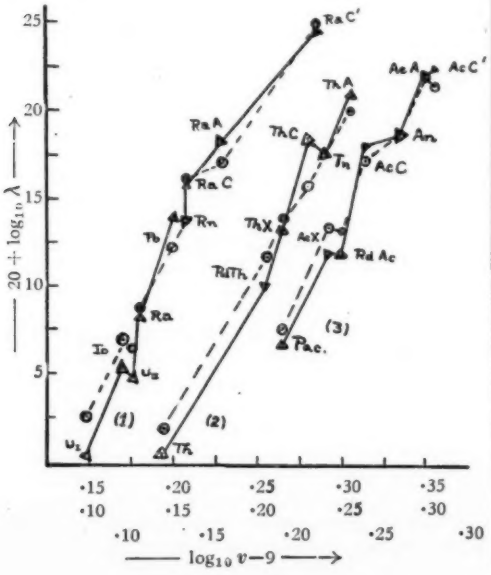


Applying the solution to the shell and using the boundary condition one readily obtains [*vide* Eq. (24) L.C.]

$$\frac{N_a}{N} = \text{const. } \cot u_0\, e^{2k(2u_0 - \sin 2u_0)} r_0^{\,2}\Delta r_0 \quad (3)$$

Combining (1), (2) and (3) we get

$$\lambda_{\text{dis.}} = \text{const. } \frac{\sqrt{E}}{r_0 h \cot u_0}\, e^{-2k(2u_0 - \sin 2u_0)} \quad (4)$$

The theoretical values of $\lambda_{\text{dis.}}$ calculated from the above equation closely agree with the standard experimental values for the three families of radioactive substances. This is evident from the graphs where the curves drawn continuous give the theoretical values.

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*May*, 1933.

### On the Two Dimensional Statistics of Kar-Mazumdar.

In a recent paper Kar and Mazumdar (*Zeit. f. Phy.*, **55**, pp. 546–554, 1929) have obtained the distribution functions of Bose-Einstein and Fermi by generalising Gibbs' statistics. In doing so, they have introduced, over and above the free energy $\psi$ per molecule, a new class of free energy $\psi_s$ per 's' type cell. Thus, according to them, the total free energy of all the cells is

$$\sum_s \Lambda_s \psi_s = \Psi_2 \quad .. \quad .. \quad (1)$$

'$\Lambda_s$' being the total number of 's' type cells.

Now, as the extension of the old statistics is ultimately due to the structure of the phase space, $\Psi_2$ may be taken also as the additional free energy of N molecules arising out of the cells. Therefore, the total free energy is

$$\Psi = \Psi_1 + \Psi_2 \quad .. \quad .. \quad (2)$$

where $\Psi_1 = N\psi$, the classical value of the total free energy.

According to the classical statistics,

$$-\frac{d\Psi_1}{dV} = P_{(\text{mol})} = \frac{NKT}{V} \quad .. \quad .. \quad (3)$$

Let us now evaluate $-\frac{d\Psi_2}{dV}$. According to Kar-Mazumdar

$$A_s\psi_s = \pm ln\left(1 \mp e^{\frac{\psi - u_s}{KT}}\right) \quad .. \quad .. \quad (4)$$

From (2) and (4)

$$P_{(cell)} = -\frac{d\Psi_2}{dV}$$

$$= \mp \frac{KT}{V} \Sigma_s \left\{ A_s ln\left(1 \mp e^{\frac{\psi - u_s}{KT}}\right) \pm A'_s \Big/ \left(e^{\frac{-\psi + u_s}{KT}} \mp 1\right)\right\} \quad .. \quad (5)$$

On substituting the usual value of $A_s$ and on integrating the right hand side of (5) we get

$$P_{(cell)} = \frac{NKT}{V}\left\{\frac{F_{3/2}(\psi/KT)}{F_{1/2}(\psi/KT)} - 1\right\} \quad .. \quad (6)$$

So the total pressure P is given by

$$P = P_{(mol)} + P_{(cell)} = \frac{NKT}{V}\frac{F_{3/2}(\psi/KT)}{F_{1/2}(\psi/KT)} \quad (7)$$

This is the well-known equation of state in the new statistics.

In the case of radiation $A_s = \frac{8\pi V \nu_s^2}{c^3}\, d\nu_s$, $u_s = h\nu_s$ and $\psi = 0$ so that $\Psi_1 = 0$, so we have as in equation (5)

$$P_{(Rad)} = -\frac{d\Psi_2}{dV}$$

$$= -\frac{8\pi KT}{c^3}\left(\frac{KT}{h}\right)^3 \times \int_0^\infty ln\left(1 - e^{\frac{-h\nu_s}{KT}}\right)\left(\frac{h\nu_s}{KT}\right).d\left(\frac{h\nu_s}{KT}\right)$$

$$= \frac{8\pi KT}{c^3}\left(\frac{KT}{h}\right)^3 \times \frac{1}{3}\int_0^\infty \frac{x^3 dx}{e^x - 1}$$

$$= \tfrac{1}{3}\,\epsilon \text{ (Planck)}$$

Thus the above discussion strongly supports the idea of the free energy of cells.

M. GHOSH.

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*May*, 1933.

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## 32-Electron System of Selenium.

IN the second* of a series of papers dealing with the investigations on the successive spectra of Selenium, it was shown that 32-electron system of Selenium consists of triplets and singlets and all the terms corresponding to the deepest 4p state and the higher 5s, 4d, 5p and $sp^3$ states were discovered. Further investigation of the spectrum has revealed about twenty new levels assignable to the doubly-ionised atom and arising from the still higher 6s, 5d configurations. For the first time in spectra of the type under consideration, some terms are also found belonging to the 4*f* state of the valence electron.

The differences $4p\ ^3P_0 - ms\ ^3P_2$ are found regularly to tend, in conformity with theoretical prediction, towards the difference $4p\ ^2P_{\frac{1}{2}} - ^2P_{1\frac{1}{2}} = 4376$ cms.$^{-1}$ of the next higher ion —Se IV.†

Full details of the investigation will be shortly published elsewhere.

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*May* 25, 1933.

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## Occurrence of Free Tyrosine in the Lac Insect (*Lakshadia mysorensis*).

WHILE investigating the nitrogenous constituents from the body fluids of the lac insect, tyrosine was found to be present free, in the water soluble portion to the extent of nearly 2·5 per cent calculated on the total water soluble nitrogen. The scarlet-red, aqueous extract of the insects, is first treated carefully with the requisite amount of barium hydroxide to remove the colouring matter. The clear light-coloured filtrate is, then, treated with phosphotungstic acid which precipitates out the more complex nitrogenous bodies. On concentrating the filtrate, characteristic crystals of tyrosine separate out.

Tyrosine has been found to occur in aqueous extracts of the earthworm, in the salivary glands of cephalopods, and in the blood of the silkworm. The febrifugal property possessed by the water extract of the earthworm is attributed to the tyrosine present in the extract. The reputed anti-

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* Investigations on the Spectrum of Se., Part II, Badami and K. R. Rao. *Proc. Roy. Soc.* (in press).

† Investigations on the Spectrum of Se., Part I, K. R. Rao and Badami. *Proc. Roy. Soc.* A., **131**, 154 (1931).

pyretic quality of the aqueous decoction of the lac insect may similarly be due to its tyrosine content.

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*June* 6, 1933.

## Action of Light on the Vapour of Tin Dihalides.

THE absorption spectra of Tin dihalides which I have been investigating for some time past have revealed certain unusual features which cannot be reconciled with the well-known theory of Franck. The absorption has been found to consist of several patches followed by transmitted regions. The details are given below. There is no sign of band absorption.

TABLE 1.

| Substance | Long wavelength limit First cut $\nu_1$ | | Long wavelength limit Second cut $\nu_2$ | | Long wavelength limit Third cut $\nu_3$ | |
|---|---|---|---|---|---|---|
| | Angstrom units | Kilocalories | Angstrom units | Kilocalories | Angstrom units | Kilocalories |
| Tin dichloride .. .. | 4480 | 69·8 | 3712 | 76·6 | 2858 | 99·6 |
| Tin dibromide .. .. | 4517 | 62·9 | 3967 | 71·7 | 3274 | 86·9 |
| Tin diodide .. .. .. | ... | ... | ... | ... | 6403 | 44 |

The values of the atomic heat of formation of $SnBr_2$ and $SnI_2$ are approximate, as the heats of sublimation for these salts have been extrapolated. It is seen that the energies corresponding to the three cuts bear the same ratio to the atomic heat of formation in the case of each of the salts. The correspondence is shown in table below.

TABLE 2.

| Substance | Atomic heat of formation of the substance in kilocalories R | $\frac{\nu_1}{R}$ | $\frac{\nu_2}{R}$ | $\frac{\nu_3}{R}$ |
|---|---|---|---|---|
| Tin dichloride .. | 176 | 0·39 | 0·43 | 0·57 |
| Tin dibromide .. | 158 | 0·39 | 0·45 | 0·56 |
| Tin diodide .. | 73·5 | ... | ... | 0·60 |

Such a correspondence has been already found by Dr. S. C. Deb* in the case of halides of Aluminium.

Of a far greater interest are the intensity conditions of the various retransmissions, the sharpness of the cuts, and the unsymmetrical widening of the absorption regions as the density of the vapour and its temperature are varied. The following explanation is made disregarding the energy considerations. It may be modified when I have microphotographed the spectrum.

The first cut can be explained as marking the photo dissociation of $SnCl_2$ into SnCl and Cl. The SnCl molecule is in the state $^2\Pi_{1/2}$ which has been postulated by Mulliken† in explaining the band systems obtained by Jevons.‡ Those bands were attributed to SnCl. The second cut can be explained as marking the photodissociation of $SnCl_2$ into Cl and SnCl in the $^2\Pi_{3/2}$ state. The difference between these two cuts is 2385 cms.$^{-1}$, the difference between the 0-0 bands in the band systems of SnCl is 2360 cms.$^{-1}$ marking the difference between the $^2\Pi_{1/2}$ and $^2\Pi_{3/2}$ states. The agreement between the difference of the two cuts and of the two states of SnCl molecule is very good.

We are not so sure about the interpretation of the third cut and possibly a fourth cut. The following explanation is offered only tentatively. The cut corresponds to the dissociation of SnCl ($^2\Pi_{3/2}$) into Sn and Cl. If its heat of dissociation be R′, and the energy corresponding to the second cut be W, then

$$R' = R - W = 99{\cdot}9 \text{ K cals.}$$

The experimental value is 99·6 K cals., which is an excellent agreement.

* Deb. Absorption Spectra of some Trihalides. *Bull. Acad. Sc.*, U.P. Vol. 1.

† Mulliken. *Phy. Rev.*, **28**, 497, 1926.

‡ Jevons. *Proc. Roy. Soc.*, A. Vol. **110**, p. 365.

Assuming the explanation for the third cut to be similar for $SnBr_2$, we find from the value of the cuts that the heat of sublimation of $SnBr_2$ should be 43·5 K cals., which seems very probable. Experiment will soon be performed for finding out the value of the heat of sublimation of $SnBr_2$ with an apparatus in this laboratory based on the effusion vapour from a small orifice.

The corresponding first and second cuts in $SnI_2$ have not yet been obtained as, according to calculation, they are expected to occur at $\lambda 1\ \mu$ and $0{\cdot}9\ \mu$. It will be difficult to obtain these photographically, but attempts are being made to get them.

The full paper will be published elsewhere.

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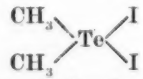
## The Constitution of Tellurium Dimethyl Dihalides from the Magnetic Standpoint.

LOWRY AND GILBERT (*Nature*, **123**, 85, 1929) studied the magnetic properties of tellurium dimethyl dihalides and found them to be diamagnetic. From this they concluded that there could be no single electron bonds in these compounds. This argument overlooks two facts. Firstly, that Sugden postulates that the single electron bond always occurs in pairs in these molecules and the compound shows diamagnetism due to the neutralisation of the magnetic field of the electrons. Sugden's postulate constitutes a *prima facie* answer, although it is an unsatisfactory answer, as it needs to be substantiated by some independent physical evidence, such as association of the molecule twice or an even number of times. The second fact which has been overlooked is that the total diamagnetic contribution of the constituent molecules may mask the paramagnetic effect of the singlet linkage and hence the value of $\chi$ at one temperature would hardly yield any conclusive evidence on the point under discussion.

Further, it also seems certain that in a compound like




the single electronic bonds should be at an angle and thus have a resultant magnetic moment.

We have, therefore, investigated the thermal variation of $\chi$ for $(CH_3)_2.TeBr_2$, $(CH_3)_2.TeCl_2$ and $(CH_3)_2.TeI_2$ and $(CH_3)_2.Te(NO_3)_2$. We find that the change of $\chi$ with temperature is negligible and so it eliminates the possibility of a masked paramagnetic configuration in these compounds. We have also employed the method of arriving at the structure of compounds by comparing the calculated and experimental values of $\chi$ after the manner of Angus and Farquharson (*Proc. Roy. Soc.*, **A. 136**, 1932). The theoretical values were computed from Pascal's data introducing constitutive correcting factors for dihalides and using all chemical bonds as simple two electron bonds. The following table gives the comparison:—

| | $\chi$ (Specific) Calculated | $\chi$ (Specific) Experimental |
|---|---|---|
| $(CH_3)_2.TeBr_2$ | 0·40 | 0·37 |
| $(CH_3)_2.TeCl_2$ | 0·47 | 0·42 |
| $(CH_3)_2.TeI_2$ | 0·37 | 0·36 |

There appears to be a fair agreement between the calculated and experimental values. There are practically no differences which can be attributed to single electron linkage and it appears that all the valencies are fully satisfied. From this and the experiments on the thermal variation of $\chi$ it appears probable that single electron bonds do not exist in these compounds.

A detailed account of the work will be published elsewhere.

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*May* 1933.

## Dilatometric Study of the Hydrolysis of Glycine Anhydride.

THE hydrolysis of glycine anhydride by alkali has been studied in the new dilatometer described by Sreenivasaya and Sreerangachar (*Jour. Indian Inst. Sci.*, **15A.**, 17, 1932). 10 c.c. of a 1 per cent solution of

glycine anhydride, prepared from glycine-ethyl-ester-hydrochloride, and 50 c.c. of 0·1 N sodium hydroxide, formed the reaction mixture. On mixing the solutions in the dilatometer, there occurs an increase in volume which is strictly proportional to the increase in dipeptide carboxyl as determined by Sorensen's formal titration. The amount of anhydride hydrolysed can, therefore, be determined from the dipeptide that is estimated. The volume change per gram molecule of the anhydride, hydrolysed to dipeptide in solution, is calculated to be 7·57 c.c. As the anhydride in solution exists in the diketo form, the above constant corresponds to the cleavage of the diketo-piperazine ring.

The study is being extended to the enzyme hydrolysis of simple peptides, peptones and proteins.

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*June* 6, 1933.

## Animals in Brackish Water at Uttarbhag, Lower Bengal.*

By Dr. Sunder Lal Hora, D.Sc., F.R.S.E., F.L.S., F.Z.S., F.A.S.B.,
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ON the 2nd of January, in an attempt to proceed to Port Canning from Calcutta by car to study the fauna of brackish pools investigated by Annandale† in 1907, I was held up near Uttarbhag on the western bank of the Piali Nadi, which could not be crossed. Though greatly disappointed at the time, we started to collect the fauna of the pools and ponds. The north end of the pond behind the "paddy" market and nearest to the road did not yield anything of unusual interest, but as we proceeded further afield, the behaviour of the fauna of the small pools and their dried-up beds provided a fascinating subject for investigation, especially the adaptations of organisms to drought and the consequent increase in salinity and foulness of the water. On account of heavy rains in the month of November 1932, there was a few inches of water in a number of comparatively shallow pools. During our subsequent visits in February and March, it was noticed that the pools had dried up completely and the water of the larger pond had fallen considerably lower. Up to the end of March, I paid four visits to the place and twice it was visited by the assistants separately (Fig. 1). The following preliminary observations on the fauna are the result of the scanty collections made during this period. The visits were mainly intended to make detailed observations on certain animals, and these will be published elsewhere at some later date.

Uttarbhag is about 23 miles from Calcutta and 5 miles beyond Baruipur; it is thus seen that the place is quite low down in the deltaic region of the Ganges. Its importance lies on account of its situation on the western bank of the Piali Nadi, one of the numerous creeks which run up into the delta of the Ganges, and on account of the fact that it is connected with Calcutta by means of a tolerably good cart road.

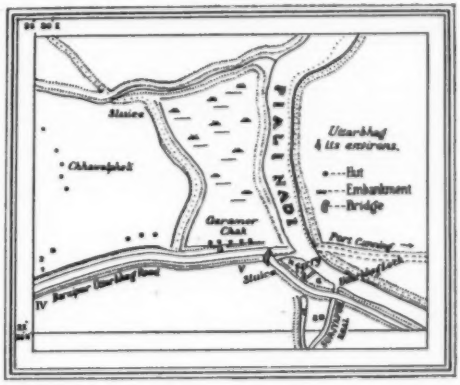


**Fig. 1.**

A sketch map of Uttarbhag and its environs, showing the position of the pools and ponds investigated.

1. Pools on the north side of the Baruipur-Uttarbhag road opposite milestone IV (fig. 4); 2. pond (fig. 5); 3. small, enclosed fisheries in front of a line of huts; 4. big pond behind paddy-market (fig. 6); 5. a series of deep pits (fig. 7); 6. shallow pools below the embankment (fig. 8); 7. a vast lake-like expanse of water; 8. paddy-field (fig. 9).

* Published with permission of the Superintendent, Zoological Survey, India.

† Annandale, *Rec. Ind. Mus.*, **1**, 35–45 (1907).

The Piali Nadi is a tidal creek connecting the Bidyadhari and the Matla rivers; it is about 32 miles in length and its width varies from 1,500 feet in the lower reaches to 400 feet near the Piali Railway Bridge. The river is embanked on both sides, so that normally its water does not now spill over into the adjoining lands. The rise and fall of the river due to tides at this place is approximately 15 feet. During the first phase of the high tide on the 13th of March the salinity of its water was estimated to be 18·08 per mille, and a sample of water taken about the middle of February at ebb tide showed a salinity of 12·30 per mille.

During the ebb tide, when the river banks are exposed (Fig. 2) it is noticed that they

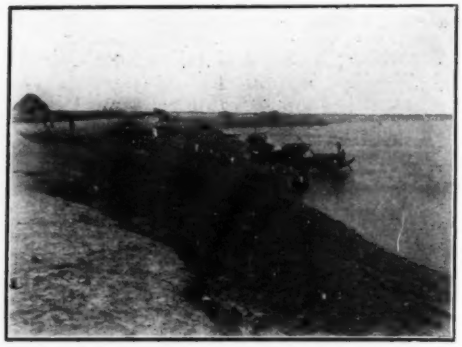

**Fig. 2.**

**The Piali during ebb tide.**

Notice the people going up and down from and to the ferry-boat respectively along the exposed, slanting and muddy bank of the river. The dark area represents the highest water level.

are lined with very fine and soft mud, into which boys sink knee-deep as they go about collecting fish and crustacea. Here *Onchidium*, a slug-like Gastropod mollusc, may be seen in countless numbers crawling about on the soft mud, on stems and leaves of vegetation or on anything that may be lying on the shore. On account of the mud-like colour of its dorsal surface, it is rather difficult to detect by unaccustomed eyes. These molluscs come right up to the highest water level, but are not to be found on the dry surface. Lower down the bank, not very far from the stream of water, the mud-skipper *Periophthalmus schlosseri* attracts one's attention as it hops about on the mud. Here it may be seen entirely out of water, so that the phenomenon of caudal respiration in reference to these fishes has to be regarded as a myth. *Periophthalmus* is a very active and watchful fish. On the approach of any object, it burrows in the soft mud, but it cannot stay there for long because it must come up to take a gulp of air for respiration, the air being stored in the gill-chambers. There are three other Gobioid fishes—*Boleophthalmus boddærti*, *Tænioides rubicundus* and *Pseudapocryptes lanceolatus*—that live in this habitat. These are also capable of breathing atmospheric air direct and of storing it in their gill-chambers for respiratory purposes (Fig. 3).

**Fig. 3.**

*Boleophthalmus boddærti* (Pall.)

Notice the bulging gill-chambers in which air is stored for respiratory purposes.

They are, however, not so active as *Periophthalmus* and prefer to lie in burrows when the tide goes out. The boys know their habits and catch them very easily. In a small pool on the bank a few specimens of *Glossogobius giuris*, *Mugil parsia*, *Aplocheilus melastigma*, *Panchax panchax* and *Aoria gulio* were taken. From the flowing water the boys had collected a number of the carp

*Barbus sophore*. The clumsy-looking, large-clawed, asymmetrical crabs of the genus *Uca* (=Gelasimus) were also common in burrows in the soft mud, while in the water the swimming crab, *Scylla serrata*, is fairly abundant.

The animals that live on the banks are subject to immersion or desiccation with the rise and fall of the river for prolonged periods.

From a sketch of the fauna of the Piali Nadi given above it may be noticed that most of the animals are typically brackish water, while the species of fish, like *Barbus sophore*, *Aoria gulio*, *Aplocheilus melastigma* and *Panchax panchax*, are primarily fresh-water species. Lt.-Col. R. B. S. Sewell has worked out the Copepods from the stream, and he also found a mixture of the freshwater species with the typically brackish water fauna of the stream. I have referred to the animals of the Piali Nadi at some length, for in studying the fauna of the ponds and pools we shall notice how these animals have now colonised the neighbouring smaller pieces of water where the conditions of existence are very hard. In Lower Bengal the rainy season lasts from the middle of June to the end of September, and during these months the country is flooded. Then the dry season sets in which lasts till the end of March. A few thunderstorms bring some rain in April, but after this for a couple of months the dry conditions prevail. During these months the animals are subjected to drought and intense heat. The salinity must also change considerably under such weather conditions. With these preliminary remarks we will now consider the fauna of the ponds and pools investigated at Uttarbhag in the order in which one meets them when travelling from Baruipur.

After travelling three miles beyond Baruipur the country opens out and vast stretches of "paddy" fields are seen on both sides of the road, which runs on a high embankment. On both sides of the embankment between it and the adjoining rice-fields, there are belts of low-lying land, about 30 to 40 feet wide, probably excavated when the embankment was made. Even now deep burrow-pits are made on the sides when the embankment is repaired. During our visit on the 8th of February, these low portions had at intervals small rounded patches where the surface was still damp and the mud soft, or where a few inches of water still formed a shallow pool (Fig. 4). Such was the condition of the low-lying belt on the north side of the road opposite milestone IV. The salinity of the water in the pools varied from 9·24 to 10·05 per mille. The bottom mud of the pools was full of the

**Fig. 4.**

A belt of low-lying land with a series of pools between the road-embankment and the adjoining rice fields near milestone IV on the Baruipur-Uttarbhag road.

Amphipod, *Grandidierella bonnieri*,* which was making burrows freely in the soft mud. Burrows of the Amphipod could also be seen on the bed of the pools where the water had just dried up. Along with the Amphipod a single specimen of a remarkable Isopod of the family Anthridæ (*Flabellifera*) was also collected. The bivalve *Cuspidaria* and the Gastropod *Melanoides* were also common at the bottom. A large number of young fish were swimming about in the pools. Most of these were *Aplocheilus melastigma*, but a few specimens of *Barbus sophore*, *Esomus danrica*, *Glossogobius alcocki* were also obtained. The crab, *Varuna litterata*, was most abundant in the pools and in their immediate neighbourhood. In a pond close by (Fig. 5) the banks were honey-combed with the burrows of this species. As the dry season advances and the pools dry up, the surface of the mud bottom becomes cracked into slabs about 6 to 9 inches deep, which become detached from the damp mud below. These cracks provide shelter for the *Varuna* crabs, but when the inner surface of the crack dries up, they make deeper burrows into the still soft, damp mud.

* For the identification of this and other Gustacea I am indebted to my colleague, Dr. B. N. Chopra.

As one proceeds towards Uttarbhag the channels on the sides of the embankment contain more and more water, till on the north side of the road in front of a line of huts one sees a number of small enclosed fisheries. On the 16th of March, when the water had fallen very low, the salinity of the water was 17·61 per mille. Besides the

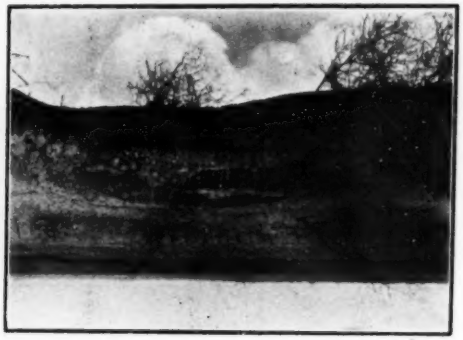

**Fig. 5.**

Pond near milestone IV, Baruipur-Uttarbhag Road (clouds are reflected in water).

Notice that the bank is honey-combed with the burrows of the crab, *Varuna litterata* Fabr.

fish enumerated above, *Aoria gulio*, *Ophiocephalus striatus* and *Ambassia ranga* were also found here. The commonest species was *Barbus sophore*. *Varuna litterata*, *Metapeneus brevicornis* and *Palæmon lamarrcii* represented the Decapod crustacea. The species of Amphipod noted above was also common here in the mud. One most interesting feature was the presence of the burrows of the crab, *Sesarma tetragonum*. The crab makes its burrows in the high banks of the water channels, and it digs its burrow to a depth of 6-7 feet or even more to reach the level of the subsoil water. The salinity of the water taken from the bottom of the burrow was found to be 11·31 per mille. There is a sluice at the head of the channel on the south side of the road, and it seems likely, therefore, that these channels are sometimes fed by the water of the Piali Nadi. There is considerable leakage of water through the sluice even when this is closed. Similarly the channels on the north side of the road are fed from a sluice about a mile and a half about Uttarbhag.

After crossing a small bridge we got to the principal market of the village and the ferry ghat. Behind and between the huts and the embankment running to the lock of the Surjyapur Khal there is a big pond (Fig. 6) or rather a series of ponds connected

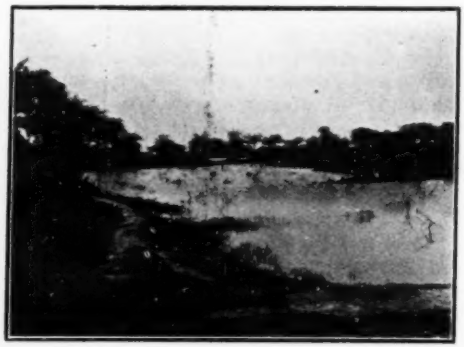

**Fig. 6.**

Large pond behind the paddy-market at Uttarbhag.

with one another by means of channels in which fish traps are placed at suitable places. By means of a narrow channel this stretch of water is put in communication with that of the Piali Nadi. At high tide the water from the river flows into this pond, while the current is reversed at the ebb tide. As has been indicated above the north side of the pond had nothing of unusual interest, but on the south side *Periophthalmus schlosseri* was present in all channels and drying up pools. *Pseudapocryptes lanceolatus* was also common in soft mud, and when the pools dried up it burrowed to depths of 5 to 6 feet. Some specimens were dug up in a more or less comatose condition. On the damp surface, *Onchidium* were also found crawling about. When digging up fishes, at a depth of 4 feet, a Polychæte worm—*Nereis* (*Nereis*) *glandicincta* Southern—was found actively crawling about in the mud. It is a brackish water species and has so far been recorded from the Salt Lakes near Calcutta, Vizagapatam and Tale-Sap in Siam. Its parapodia are peculiar and are probably adapted for burrowing in soft mud. Its fassigerous bristles are provided with long knife-like terminal pieces. Even in water the movements of this worm are very rapid. In the soft mud oligochæte worms were also present. On the 2nd of January the salinity of water on the north side of the pond was 4·16 per mille.

Between the narrow channel connecting the large pond with the Piali River and the

huts there is a series of deep pits (Fig. 7) from which mud seems to have been taken for building purposes. During our first visit some of these were dry, while there was a few inches of thick, foul-smelling water in others. From one of these a specimen of

**Fig. 7.**

Deep and drying-up pits to the south of the paddy market just behind the huts.

*Mugil parsia*, nine inches in length, and a specimen of *Aoria gulio* were taken. *Onchidium* crawling on the damp surface, *Periophthalmus* hopping about and Amphipods burrowing in mud were the other characteristic animals of these pools. A dried-up pool was dug up and one specimen of *Periophthalmus*, a few *Varuna* crabs and two specimens of *Pseudapocryptes* were taken out. This also shows that the belief that the respiration of *Periophthalmus* can be and is carried on by the tail, which is kept in the water, must be treated as a myth. Attention may here be directed to the curious fact that a large number of the empty burrows of *Pseudapocryptes* contained young examples of the Python, *Python morulius*. Whether these young snakes had eaten the fish or had entered empty burrows could not be ascertained.

A few paces beyond these pits, and after crossing an embankment, is a small piece of land which is overgrown with a species of a small xerophytic plant, *Suæda maritima*. At exceptionally high tides the water from the Piali Nadi flows in one or two places over the embankment and floods this land. Below the embankment to the Surjyapur Khal, there is a series of shallow pools (Fig. 8), probably the remnants of the old burrow-pits. The flood water accumulates in these pools. During the four visits, I have seen them both full of water and in an almost dry condition. Probably they receive the Piali water at the spring tides and dry up in the intervals between them. The fauna was the same as that of the pits described above and when a portion of a pool was dug up, a *Periophthalmus* and a few *Varuna* crabs were taken out. Two

**Fig. 8.**

A series of shallow pools below the embankment to the Surjyapur Khal.

days after the spring tide on the 16th of March the salinity of the water was estimated to be 18·40 per mille.

On the other side of the embankment is a lake-like stretch of water which is connected with the Surjyapur Canal on the south side and ends blindly on the north side. About the middle of March its salinity near the north end was 6·28 per mille. We were fortunate enough to see it being fished with large nets. *Lates calcarifer*, *Labeo rohita*, *Cirrhina mrigala* and *Catla catla* were the principal food fishes that were being collected. Among the smaller species we found *Barbus ticto*, *B. sophore*, *B.gelius*, *Aoria gulio*, *Panchax panchax*, *Aplocheilus melastigma*, *Trichogaster fasciatus*, *Ambassis ranga*, *Pseudapocryptes lanceolatus*, *Ctenogobius alcocki* and *Butis butis*. In the adjoining paddy-field some boys were collecting fish in small pools of water (Fig. 9). The salinity of the water was 4·38 per mille and it was smelling strongly of sulphuretted hydrogen. The catch of the boys consisted of the *Varuna* crab, four species of prawns—*Metapeneus monoceros*, *M. brevicornis*, *Cardina propinqua* and *Palæmon lamarreii* and

15 species of fish—*Aoria gulio, Barbus ticto, B. sophore, Esomus danrica, Xenentodon cancila, Panchax panchax, Aplocheilus melastigma, Mastacembelus pancalus, Ophiocephalus striatus, O. punctatus, Anabas testudineus,*

**Fig. 9.**

Boys catching fish in a drying-up portion of a paddy-field.

*Nandus nandus, Ctenogobius alcocki, Glossogobius giuris* and *Pseudapocryptes lanceolatus.* A couple of days after our visit these pools dried up altogether and when a portion was dug up a few *Varuna* crabs were found æstivating.

From the above brief and incomplete sketch of the animal life in brackish water at Uttarbhag it is clear that a number of freshwater species, such as Cyprinoid fishes, have migrated into brackish water and can now stand a salinity half as much as that of the sea water. On the other hand, the characteristic marine fishes, such as the Gobies, have migrated upwards into brackish water. The main interest of the brackish water fauna lies in the fact that it comprises peculiar and highly adaptable forms, which seem to have been derived from both the marine and the freshwater elements of the adjoining regions. This animal association shows great adaptability to changes in salinity, partial or complete drought, muddy water, soft and muddy bottom, etc. It has been stressed by several observers, and there is no reason to disagree with them, that the estuarine regions serve as the nurseries for the evolution of the true freshwater fauna, and it is universally believed that life originated in the sea and even now it is most prolific and diversified in the salt waters. In the regions, such as that described above, the evolution of the freshwater fauna can be followed even to-day and the various factors that brought about this fundamental change can be studied.

## A Suggestion as to the Origin of Tornadoes in Bengal.

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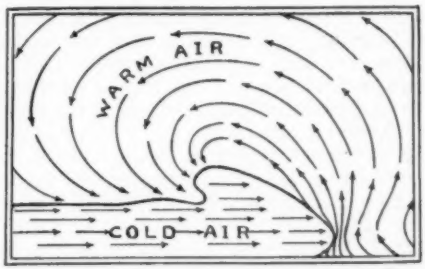
IN a paper, which is to appear shortly in the *Gerlands Beiträge zur Geophysik*, I have dealt in detail with the mechanism and the mode of propagation of thundersqualls which are common in Bengal, particularly in the early summer and the autumn months. The mechanism put forward there has been shown to explain all the important features of these well-known squalls; in particular the velocities of nor'wester squalls have been theoretically calculated from the observed sudden rise of barometric pressure and fall of temperature accompanying these squalls in a large number of cases chosen at random from the meteorological records of the period 1905-1932. Assuming that a thundersquall is the process of sudden replacement of the existing warm air by a sample of cold air so that the rise of pressure observed at the onset of a thundersquall is due to the weight of the layer of cold air which flows underneath the warm air, the velocity (V) of propagation of a thundersquall is given by the following relation:

$$V=\tfrac{2}{3}\sqrt{\frac{2RT^2}{T'}\cdot\frac{\triangle B}{B}},$$

where R=the usual gas constant, T′=temperature of the warm air, and T=temperature of the cold air, B=barometric pressure before the onset of the squall and $\triangle B$=rise of pressure during the squall. In deriving the above formula the vertical gradients of temperature in the two samples of air have been neglected. But the formula can easily be modified to include the temperature lapse-rates, in which case pressure is eliminated from the formula. It has been found

that there is a good agreement between the velocities calculated with the help of the above relation and the velocities actually recorded by anemographs. A method of forecasting the velocities of the squalls as well as the direction of their motion has also been indicated in the paper referred to above. It has, moreover, been shown that the same mechanism, although put forward primarily to explain those thundersqualls which are accompanied by a sudden rise of barometric pressure and a simultaneous fall of temperature, explains in quite a natural way the different types of temperature changes recorded during thunderstorms not only in Bengal, but in other parts of India as well.

In this note I wish to outline the process of formation of a tornado (or waterspout) on the basis of the mechanism proposed for thundersqualls, and for this purpose I shall first briefly state the main points of this mechanism. The principal constituents of a thundersquall, as is well known, are a cold sample of air and a warmer (and therefore lighter) sample, the colder air moving under favourable circumstances into the region occupied by the warm air. Once the motion is started it will continue till the cold air penetrates, due to its higher density, under the warm air which will therefore be forced to rise. According to this mechanism the penetration of the cold air will have all the essential properties of a cold wave and will take place in the same way as observed by W. Schmidt in his idealised laboratory experiments; in other words, the cold air will develop a "hump", or squall-head, so that the warm air will be vigorously forced up in the front of the cold air and after passing over the top of the squall-head it will come down in its rear. This motion will therefore tend to produce a whirl with a horizontal axis in the upper air in the rear of the squall-head. It may be mentioned here that this point of view is strongly supported by the peculiar shape of the squall-head as obtained by Schmidt in his laboratory experiments (see Fig. 1) as well as by the characteristic anvil form of some cumulo-nimbus clouds. That the advance of cold air from one part of the atmosphere into another takes place in such a way that the discontinuity surface is steepest in the front of the cold air and not uniformly sloped as would be suggested by the idea of a cold air "wedge" is a well-known fact verified by the observations of G. Stuve and others. Also the usually observed formation of rain clouds in the front of advancing cold air and the clearing of the sky after the passage of the cold front would receive a natural explanation from the ascent of warm moist air in the front and its descent in the rear of the squall-head. If the temperature contrast between the two air samples is sufficiently sharp a complete whirl can be




formed and be maintained for a long time since it can draw its supply of energy from the cumulo-nimbus cloud inside which it is formed. This whirl with horizontal axis is probably the "mother vortex" responsible for the occurrence of tornadoes (or waterspouts) in Bengal in association with the nor'wester squalls. It is to be remarked that the existence of a steep or superadiabatic temperature gradient prior to the advance of the cold air would add to the intensity of the whirl brought about by the mechanism of squall-head, although a steep or superadiabatic gradient does not by itself necessarily cause an overturning of the strata. It may be mentioned, however, that it is not necessary that the motion of the cold air should always take place along the ground; there may be a similar motion of cold air from one part of the free atmosphere to another giving rise to the "mother vortex", so that although nothing striking is noticeable on the synoptic weather maps a tornado may occur simply as the result of conditions in the free atmosphere. On many occasions, however, sharp contrasts of temperature (and perhaps sharp discontinuities in other meteorological elements also) should be noticeable in the horizontal as well as vertical directions. The absence of pronounced indications on the surface weather charts before the occurrence of certain tornadoes should not be surprising, for a tornado is essentially an upper air phenomenon which eventually affects the ground level under favourable conditions.

As a matter of fact, tornadoes with a horizontal trunk, which does not reach the ground level at all, have occasionally been observed in Europe (*e.g.*, the tornado of 16th May 1887 at Teplitz).

From a study of over 250 tornadoes in Europe, A. Wegener[1] came to the conclusion that the tornado has its origin in a whirl with horizontal axis, which he calls the "mother vortex", formed inside the giant cumulo-nimbus which accompanies the tornado. The manner in which objects are carried high up in the atmosphere by a tornado, first in a more or less vertical direction and then horizontally till finally they are thrown down on the earth at a considerable distance from where they were picked up, can be satisfactorily explained by the idea of the "mother vortex", whose horizontal axis ultimately bends down at the ends towards the ground. It is easy to see that the whirl, which should sometimes come into being as a result of the mechanism of Bengal thundersqualls indicated above, should have properties very similar to those of Wegener's "mother vortex". In Bengal the warm moist air which is lifted by influx of cold air in a thundersquall blows from a southerly direction. The whirl which forms in the lee of the squall-head should therefore move in a northerly direction approximately opposite to the direction of motion of the cold air. The exact direction of displacement of the whirl will, of course, be considerably influenced by the prevailing upper winds. If in a particular case the cold air travels from north-east towards south-west, the axis of the whirl will be approximately in N.W.—S.E. direction, so that looking from south-east the rotation of the whirl will be clockwise, while looking from north-west it will be counter-clockwise. If now the ends of the whirl bend downwards we have two more or less vertical vortex pipes, one on each side of the cumulo-nimbus tower, which should form approximately on the top of the squall-head. The vortex pipe on the right-hand side is the one that usually constitutes the tornado, probably because the existence of a convergence line on this side favours its formation; the vortex pipe on the left does not seem to have yet been observed with certainty. Looking in the direction of motion of the warm current, therefore, the vortex pipe on the right-hand side of the cumulo-nimbus tower would have (looking as usual from above) an anti-clockwise rotation, with air ascending, while the one on the left, if it does form, would have a clockwise rotation with air descending towards the ground.

Since there is no *prima facie* reason for believing that the tornadoes of India are different in their mechanism from those of Europe, it appears very probable that the tornadoes which occasionally form in Bengal in association with thundersqualls owe their origin to the mechanism suggested above. Unfortunately, no observations are available for Bengal tornadoes and there is no established theory about them. In order to test the tentative mechanism of the origin of tornadoes in Bengal put forward here or to evolve a satisfactory theory it would be essential to make not only a careful and systematic investigation of the areas of destruction with a view to finding out the nature of the wind motion in different tornadoes, but also regular observations of the barometric and thermal structure of the atmosphere at a large number of stations. The upper air instruments which I have described elsewhere[2] should be of considerable help in this matter: but the co-operation of the scientifically inclined public in making visual observations would greatly advance the cause of tornado research in Bengal, particularly with a view to determining the way in which objects are carried up and thrown about by tornadoes, and also how the areas of rainfall are situated with respect to the path of destruction.

[1] A. Wegener. *Wind und Wasserhosen in Europa*, 1917.
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[2] A. K. Das. *Gerl. Beitr. z. Geoph.*, **36**, 1, 1932.
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# On the Bionomics, Structure and Physiology of Respiration in an Estuarine Air-breathing Fish, *Pseudapocrytes lanceolatus* (Bloch and Schneider)

## With Special Reference to a New Mode of Aerial Respiration.

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IN his monograph on the air-breathing fishes in the *Phil. Trans. Roy. Soc., London*, 1927, the author has given a fairly complete account of the structure, development and physiology of a certain interesting group of air-breathing fishes of India. A general account of the habits and the curious mode of aerial respiration (hitherto unknown) of this estuarine Gobiid was submitted by the same author at the two meetings of the Indian Science Congress held at Allahabad (1930) and at Bangalore (1932), which has already been published in the Proceedings of the said Congress. The following is a summarised report of the outstanding facts contained in his elaborate paper which has been sent for publication elsewhere:—

(1) *Pseudapocrytes lanceolatus*, commonly called 'Goolay' in Bengal, is a small, eel-like estuarine Gobiid (Fig. 1, *a*, *b* & *c*) about 15·2 cms. in length and with a maximum girth of 5·6 cms., having very slippery skin with minute cycloid scales, and often residing in muddy localities and also in burrows situated near water, æstivating* during the hot months, very similar in habits to another fresh and brackish water fish *Amphipnous cuchia*. The fish was procured from the estuarine parts of Bengal, *viz.*, Port Canning and Diamond Harbour, within an easy reach from Calcutta. It can also be had plentifully during the months of October and November from the Calcutta markets. The fish possesses a non-cellular physoclistous type of air-bladder. The habit of æstivation is generally prevalent amongst air-breathing fishes as described by the author in 1927, and it is an adaptation to avert drought when the small sheets

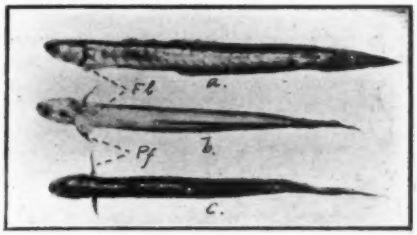


**Fig. 1.**

(*a*, *b* and *c*)—Representing lateral, ventral and dorsal aspects of *Pseudapocrytes lanceolatus* respectively. Fl=Ventral "disc" (*i.e.*, the united ventral fins). Pf=Pectral fins.

of water in which these fishes are confined usually dry up (*cf.* Burrowing habits of Dipnoi due to similar environmental conditions and especially the vitality of the African genus, *Protopterus*, which could lie dormant in its cocoon for nearly five months are quite well known‡).

(2) The opercular chamber is a small sac-like structure supported by very thin and elastic opercular bones, and the gill-opening is quite narrow, about 8 mm. in length. The closing of this opening is due to the sticky secretions poured by the innumerable number of mucous glands present along the opercular rim as well as to the pressure caused by the forward rotation of the fleshy lobe of the pectoral fin (Pf).

(3) Biserial type of gills is present, but the 4th gill is extremely small. In addition each primary gill-filament is divided into several very small leaf-like secondary filaments (not so prominent in purely water-breathing fishes), evidently meant to present a larger area as well as to make a more

* Fishes (no matter whether brackish or fresh-water forms) generally spending most of their life in muddy localities (and the same thing being too well known in the case of such remotely distributed fishes as the Dipnoi living under similar environmental conditions) are obliged to adopt such a mode of life in order to avoid death when the liquid mud periodically dries up during summer, and hence if such fishes are to survive at all and to make their life a success by leaving their progeny and so to continue their race, then they must take recourse to some means to escape death and extinction, and, therefore, the easiest way for them is to get themselves buried inside the wet mud and remain in burrows for some time in a state of torpor until such time as the rains set in and again resuscitate them once more from their summer sleep. (Day, 1868; Dobson, 1874; Das, 1927) [*cf.* Discussion part of the original paper.]

‡ [*Cf.* Discussion part of the original paper.]

efficient mechanism for the absorption of as much oxygen as possible present in the surrounding medium, which is usually very deficient in oxygen.

(4) When the water is dirty (that is to say, poor in oxygen), the fish occasionally comes to the surface to breathe in atmospheric air directly. The inhaled air is retained in the opercular chambers, which become bulged out like two little "bladders" (*cf.* Pharyngeal "lung" of *Amphipnous*, Das, 1927) on the sides of the head, and in this position the fish floats about *passively* (generally 2-4 minutes), with stretched out pectoral fins, almost lying vertically upwards (Fig. 2), probably due to the buoyancy


**Fig. 2.**

The usual attitude of the fishes in a glass aquarium, hanging almost vertically upwards with their air-filled opercular chambers and passively moving about due to buoyancy.

caused by the air-filled chambers, and from a distance every one appears as if it is a dead fish. These are analogous with the bladder-like structures of *Amphipnous* but not homologous with them; they are, however, homologous with opercular "lung" of other air-breathing fishes described previously (*cf.* Das. 1927). In clearer water, however, the frequency to snap air becomes reduced. The fish is usually very shy, and wriggles back quickly to the bottom after getting rid of the contained air from the opercular cavities should any disturbing element approach it. Confined in an aquarium containing dirty water the fishes are very often observed to push one another and make vigorous attempts to reach the surface in order to breathe air, and under such circumstances some are found even clinging to the sides of the vessel far above the water level (Fig. 3).

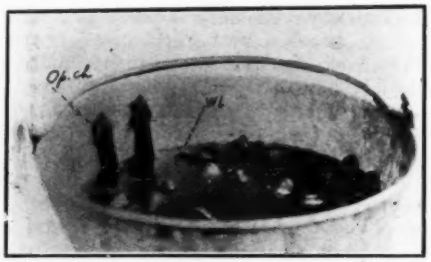


**Fig. 3.**

Same fishes confined in dirty water in a bucket and two of them seen popping out nearly 2 inches above the level of water and clinging to the sides of the vessel on the left, having their opercular chambers (Op. ch.) bulged out with inhaled air, whilst others are vigorously struggling for air, and look like so many large tadpoles. Wl=Water level.

(5) The used-up air is got rid of from the mouth, unlike the majority of the air-breathing fishes (Das, 1927), with a certain force due to which a clicking sound is produced as in *Amphipnous*. The air is forced out due to the collapse and pumping out action of the opercular chamber owing to the elasticity of its own walls (as in *Amphipnous*) and at the same time assisted by a spring-mechanism associated with ceratohyal and the last branchiostegal ray.

(6) The opercular chamber and the mouth-cavity are highly vascular, and this state of affairs, particularly associated with the latter, must be responsible to a very large extent for the *bucco-pharyngeal* respiration taking place in this fish. This phenomenon, however, is much less marked in the great majority of the air-breathing fishes, except in *Ophiocephalidæ*, *Periophthalmus* (the "Walking Goby") and *Hypophthalmichthsy* (Rauther, 1910).

(7) It has been observed that in fishes whose opercular chambers are slightly vascular, they have been found to survive for at least some time out of water (*e.g.*, certain smaller species of the fresh-water genera of fishes, such as Macrones and possibly many others). This kind of structural modification undoubtedly prepares an initial ground for aerial respiration. In addition there are some other purely water-breathing fishes that can live for a long time out of water although they possess no special air-breathing organs. Many coastal fishes such as *Periophthalmus* and *Boleophthalmus* and others have also been discussed.

(8) If certain weeds are placed in the aquarium they push their way through the meshes in between those weeds, hang on to them with their widely spread out pectoral fins, ultimately lift their heads above the surface of water (looking like so many large tadpoles) with the object of breathing atmospheric air, which they do quite vigorously.

(9) While lying at the bottom in clear water they perform the usual branchial respiration—the branchial oscillations varying from 70-80 per minute under normal conditions. In this position they sometimes also creep about due to the alternate to and fro movements of their pectoral fins. The fish becomes very much excited, and the branchial oscillations are accelerated, if it is introduced in muddy water.

(10) Locomotion on land in a serpentine manner (more or less like *Amphipnous*) is effected by the sculling action of the pectoral fins and at the same time the ventral "disc" (Fig. 1. Fl) acting as a fulcrum and also to a very large extent assisted by the lateral flexions of the tail. Occasionally the fish struggles over the ground and makes jerky leaps due to the beating and spring action of the tail, and this performance coupled with the slippery skin of the fish enables it to reach its natural element quickly. It can survive for nearly two hours out of water in absolutely dry condition, temperature of air being, on average, 86°—94°F, or sometimes even more.

(11) The opercular chamber is innervated by the fine ramifications of the ramus hyomandibularis.

(12) In correlation with the initiation of a regular air-breathing habit influenced by peculiar environmental factors (mainly low $O_2$-tension of water) several very interesting structural modifications and functional adaptations have evolved in this fish, especially with regard to its vascular system, *viz.*,

(*a*) Highly vascular character of the buccal cavity as well as the opercular chambers.

(*b*) The presence of a large number of secondary gill-filaments in the gills means (like the villi of the alimentary canal) an effective mechanism for the absorption of as much oxygen as possible from the surrounding water which usually holds very little of the dissolved gas.

(*c*) Bucco-pharyngeal respiration is evidently effected by the vascularisation of the buccal cavity: blood is taken to this region and also to the opercular chamber by an artery, equivalent to the so-called "Hyoidean" artery of *Neoceratodus* (which divides into two, *i.e.*, the *afferent buccal* and the *afferent opercular* respectively) given off from the 1st afferent branchial vessel. Besides, the 2nd afferent also makes contribution of a certain part of its impure blood to these areas for the purpose of purification.

(*d*) The blood after being purified at the mouth-cavity and the opercular chambers is drained by means of the factors of the *jugular vein* which thus carries the *mixed* blood directly to the heart.

(*e*) Mixed, *i.e.*, already partly oxygenated blood, therefore, circulates in the heart, and is then pumped to the gills for purification. This mode of circulation of the previously *partially aerated* blood in the gill-capillaries must have evolved as a special adaptation with a view to cope with the oxygen-deficiency of the surrounding water, or else the fish would die of asphyxia. This is a very unique adaptation indeed, and is resorted to by a great majority of the air-breathing fishes. In the case of *Amphipnous cuchia* and *Monopterus javanensis mixed blood circulates even in the dorsal aorta* (*cf.* Amphibians and Reptiles). Of course, amongst fishes the vascular system of the Dipnoi, as is very well known, is most highly evolved, and approaches very near the condition existing in Amphibians, and the physiology of circulation in these Indian air-breathing fishes is certainly a great advance over the one existing in the common teleostean fishes, and is undoubtedly an outcome of the reaction to their environment.

(13) A series of physiological experiments have been carried on subjecting the fish to varied conditions of water (such as muddy or foul water having low $O_2$-tension), noting

down its movements and behaviour in absolutely dry conditions as well as certain causes and circumstances under which asphyxiation takes place (the period of "drowning" being much greater in this fish than in all other air-breathing fishes so far recorded by the author).

(14) Apart from the branchial respiration taking place normally amongst fishes, a habit of breathing atmospheric air directly is at first very slowly acquired by some of them living under very abnormal conditions of water, that is to say, its low $O_2$-tension. This habit becomes gradually ingrained in the species, and then becomes intensified in course of generations. The possession of various types of air-breathing organs in fishes, which have certainly evolved quite independently, showing different degree of modifications and complexity of structure, is really an index of the magnitude of the reaction to environment, leading towards the amplification and intensification of such a habit in different fishes which have adapted themselves to various conditions of life. "*Habit after all is second nature, and nature is only a name for first habit.*" We can thus picture in our minds as to how physiologically equivalent structures could possibly evolve under the influence of similar environmental factors, governed by similar natural forces, a case of parallelism in evolution in so many remotely related fishes, inhabiting different parts of the globe, *viz.*, the lungs of Dipnoi and the accessory air-breathing organs (in other words, the "lung mimics") of certain Indian teleostean fishes. Such facts are of fundamental importance, and certainly help us towards the understanding of the real course of Evolution.

(15) As a matter of fact it is often observed that even the best of the water-breathing fishes, *viz.*, Cyprinoids, most Siluroids and others, would madly run up to the surface of water in quest for a gulp of air, if the normal medium in which they live is rendered foul and turbid, or, in other words, if its oxygen-tension becomes considerably low, in as much the same way as what would happen if bubbles of $CO_2$ are continuously passed in an aquarium containing such fishes. Such a phenomenon is to be seen in a tank or a pond (nay, any small sheet of water containing fishes) which is rapidly drying up during the summer months (especially May and June), and such a state of affairs may be termed "*Notatmung*" (*i.e.*, breathing in a state of 'distress'), and indeed it is a very simple process to which the fish is forced to adapt itself under conditions of extreme deficiency of oxygen with a view to avert death due to asphyxia. It merely consists of aerating its mouth-cavity (*i.e.*, "mouth-ventilation") by constantly taking in of fresh bubbles of air and then giving them out after use at a fairly brisk rate. This mode of breathing (or as it is commonly called "gasping") performed by a large number of species of typically water-breathing fishes, *viz.*, Rohu (*Labeo rohita*), Mrigala (*Cirrhina mrigala*), Catla (*Catla buchanani*), many siluroids, etc., is a common sight in any such tank or pond in most parts of India during the hot summer under the mid-day sun, when the temperature of water naturally rises high and varies from 90°–100°F, or sometimes even more! Such a small beginning of taking in of atmospheric air directly would certainly stimulate and account for the development of accessory air-breathing organs in fishes in addition to their usual branchial mode of respiration.

(16) The course of evolution of the various types of air-breathing organs has been graphically illustrated towards the end of the paper: the opercular chamber of *Pseudapocrytes* undoubtedly represents *the simplest and the most primitive kind of a true air-breathing organ*, and forms the land-mark and the starting point from which the evolution of the *opercular "lung"* of other fishes must have taken place. This fact has already been foreshadowed during the course of the detailed study of the air-breathing organs of the fishes made by the author in 1927.

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## Notes on the Kabuis of Manipur

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THE Kabuis, it might be remembered, had recently witnessed a reaction against modern culture culminating in the revolt and capture of the semi-mystic, semi-political, 'Gadaulu' comparable to the 'Birsha' movement of the Mundas. Working amongst them twenty miles away from Imphal in 1931-32 we could gather many new data and check up some of the information given by Mr. T. C. Hodson. This group wedged in between the highly civilised Manipuris on the one hand and the more primitive Kukis on the other and linguistically more akin to a third group—the Nagas, is very interesting and a few striking features are given below.

The Kabuis generally inhabit the hills to the west and north-west of the Manipur valley. They are scattered over this tract sometimes in small and sometimes in large villages far away from each other. The large villages generally contain fifty to sixty houses and ten small villages of six or seven houses can also be found. Each house is inhabited by a single family, *i.e.*, father, mother and children.

By the very first glance at a Kabui a Mongolian strain can easily be detected by the typical Mongolic fold, the high cheek-bone and other characteristics. They are of moderate stature and tall men among them are very rare. The girls are generally ugly in appearance and have no idea of beauty and they shave their head till their marriage but now-a-days in some villages near Imphal girls dress their hair in the Manipuri pattern.

The Kabuis have got a large number of clans and these clans are divided into three divisions. These three divisions are exogamous. The kinship system of the Kabuis is classificatory and only eighteen words are used to address different relatives. They can marry their mother's brother's daughter but no other cousins are allowed to marry. Junior lavirate is very common among them but my informant told me that senior lavirate was also allowed by the society. Sororate is also in vogue among them. 'Cheralung Luklakpa' (the second headman of the Noriya village) married both the daughters of 'Khunemlank' at a time; but this type of marriage of two sisters with one man at the same time is not very common.

The Kabui society is very elastic and its members are adopting new units into their own group. When taking genealogies a case occurred in which Singhir, a Garhwal from Nepal, was allowed to marry a Kabui girl and he was adopted in the royal clan of the Kabui society.

The Kabuis have the annual festival of 'Kumaichourel' in the month of January and at that time they offer sacrifices in honour of the dead persons and are engaged in dancing and music for some days.

The Kabuis near Imphal are much influenced by the Manipuris and day by day they are adopting the culture and the mode of living of the Manipuris and probably within few years one will hardly recognise a Kabui village from the Manipuri.

# On the Possibility of Cultivation of Saffron *Crocus sativus* (Fam. Iridaceæ) in the Hyderabad State and its Importance.

By Inam-ul-Haq and M. Sayeeduddin, M.A., B.Sc., F.R.M.S.,
*Professor of Botany, Osmania University.*

IT is still maintained by the majority of people who know anything about cultivation of *Crocus sativus* that Kashmir alone can boast of cultivating it, and that no other soil and environment is suited for its growth. Our intention in writing this note is to bring to the notice of the learned readers that we have been able to perform a fairly successful experiment on the possibility of the cultivation of *C. sativus* in Hyderabad.

It is believed by the Kashmirees, we are told, that this plant can be successfully cultivated only in certain areas and not in others; the prevailing belief is that saffron is the gift of a faqir (a saint we suppose) who lived near the village of Pampur. The land where he had ordered the seeds to be grown is the only area where this plant can thrive, and even the adjacent land does not yield saffron. Whether it is this belief that keeps back people from experimenting on different areas or not we are not able to say definitely. On the other hand it is said the soil was specially imported in Kashmir for growing this plant. As it is well known the famous saffron fields are situated in the vicinity of Pampur, on a plain fifty feet above the valley. All the four stations where *C. sativus* is grown are tree-less table-lands on an elevation of 5,200 feet above the sea-level. One of the authors (Mr. I. Haq) had been to Kashmir in the year 1929 to collect information about the cultivation of saffron. It was found that this plant is cultivated in stiff clay on raised parterres even without ploughing and irrigating it. The bulbs are planted out in June or July and the stigmata are collected in October or November.

About two years ago one of the authors managed to get the permission of the authorities to carry out his experiment on a small plot of ground in the Public Gardens, Hyderabad. Altogether thirty-two bulbs were planted out in a well-prepared soil under the poor shade of guava trees. In spite of the season being over and not having been properly taken care of every one of the bulbs brought forth a shoot which attained a height of about 13-14 inches. It being too hot in the year for the plants to thrive and flower they soon withered away. But the very fact that the bulbs produced quite healthy plants in spite of the conditions not supposed to be suited for their cultivation is very promising indeed. Given proper facilities for experimenting we believe that *C. sativus* could be cultivated in Hyderabad in enough quantity to meet the local demand. Like Dr. Downes we are of opinion that a special soil is not needed for the cultivation of *C. sativus*. It is possible that the climatic conditions prevailing here might affect the quality of saffron obtained. But the customary belief, that no soil other than that of Kashmir is suited for the growth of *C. sativus*, seems to us to be erroneous.

The uses which we have been able to gather from different sources are the following:—

*Economic:* In the majority of our dishes saffron is used as a colouring and flavouring agent. Dissolved in water it is used as an ink with which our priests and *amels* write charms or *tawiz*. *Medicinal:* Saffron is considered by our *hakeems* as hot and dry. It is said to reduce inflammations. It is a stimulant and stomachic. Considered a good remedy for enlargement of the liver and affections of the urinary bladder and kidneys, also in cholera. Administered in big doses it makes the patient unconscious. Mixed with other drugs it is used to help menstruation. It is strengthening to the heart and is a refrigerent for the brain. If soaked overnight in water and administered with honey it makes the patient suffering from urine trouble to pass the urine freely. Pounded with ghee it is used in diabetes.

Saffron oil is used as an external application in uterine sores. After extracting the oil from saffron the waste is also used in many diseases.

Considering the uses to which saffron is put it is worth while experimenting in different parts of India on its cultivation. Undoubtedly it is a very paying experiment.

We are indebted to Hakeem Yaseen Khan for giving us reliable information about some of the uses of saffron in native medicine mentioned above.

*References:*

*Pharmacographic indica.*
Kirtikar—*Indian Medicinal Plants.*

## Obituary.

### Prof. G. C. Bourne, F.R.S.

WE regret to announce the death of Prof. Gilbert Charles Bourne, Emeritus Professor of Zoology and Comparative Anatomy in the University of Oxford, on March 8, at the age of 72.

After finishing his studies at Oxford and Freiburg he was elected a Fellow of New College and later its Tutor. He was then appointed as the Director of the new Marine Biological Laboratory at Plymouth, but after two years returned to his old University of Oxford, and in 1906 succeeded Prof. Weldon in the Linacre Chair of Zoology and Comparative Anatomy, which he occupied with distinction till his resignation in 1921.

Prof. Bourne besides publishing a large number of original papers on various subjects such as the Anatomy of a Millipede, the Structure and Growth of various Corals, the Anatomy of the Neritacea and other gastropods, an elaborate study of the crabs of the family Raninidae, was the author of one of the best elementary text-books on Comparative Anatomy entitled "An Introduction to the Study of the Comparative Anatomy of Animals" and contributed several parts to Lankaster's well-known "Treatise on Zoology".

Prof. Bourne was a brilliant teacher, of a friendly and generous disposition and was well known for his work as a rowing coach in the University of Oxford. He served in the Boer War, and during the World War was engaged in the training of recruits. Since 1919 he took a very active part in the work of the Advisory Committee on Fishery Research to the Development Commission of which he became the Chairman in 1931. He also did valuable work in connection with the Water Pollution Research Board of the Department of Scientific and Industrial Research.

He was elected a Fellow of the Royal Society in 1910, and was President of Section D (Zoology) of the British Association at Sheffield in the same year.

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## Research Notes.

### Vivipary on the Sea-Shore.

A NEW explanation of the prevalence of the viviparous habit in the mangrove forests along the sea-shore, based on recent ecological work, is suggested by Mr. A. C. Joshi in the last number of the *Journal of Ecology* (Vol. XXI, No. 1, Feb. 1933). The author in his paper shows how the old hypotheses of Guppy, Schimper, Warming, Haberlandt, etc., are unacceptable in the light of present knowledge. His own explanation is as follows: "Recent experiments have shown that while many plants can grow in a saline soil, their seeds cannot germinate in such a soil—the salt solution hindering water absorption which is always essential for the germination of the seeds. The seeds of most inland halophytes germinate, most probably, only after good rains when the soil solution is very much diluted, but such a thing is not possible in the mangrove swamp and on the sea-shore. Rains make no difference there and the salt-content of the soil remains high and approximately uniform throughout the year. Vivipary or the germination of the seeds on the parent trees themselves is the only method by which the injurious action of the salts of the soil on the seeds, preventing them from germination could be avoided and it appears that this is the reason that plants with a viviparous habit have gradually become grouped on the sea-shore. The habit probably arose independently in the different plants in different localities as a variation from the normal due to environmental effects or some other unknown causes, as is fully proved by the occasional occurrence of vivipary in land plants in places remote from the sea. Of these species, the halophytic gradually shifted to the sea-shore where this habit proved really useful and, under the uniformly warm and saturated atmosphere of the tropical littoral lands, the original variations became a regular habit with the species. This habit is still very strong in the various mangrove species because it is really useful to them in tiding over one of the greatest obstacles in their environment."

### Quadrics of Revolution through a Pair of Skew Lines.

IN a paper published in the *Jour. of the Indian Math. Soc.*, Vol. 17 by A. Narasinga Rao, a study was made of the metrical structure of the system of quadrics of revolution through a given conic, by obtaining an image of the system in line space, each quadric being represented by its "axis" of revolution. It was shown that the system was composite, the "axes" lying in one or other of two planes, the distinction corresponding to that between "prolate" and "oblate" spheroids.

In a sequel to the above, in the *Annamalai University Journal*, Vol. II, No. 1, the study is extended by A. Narasinga Rao and N. S. Srinivasachari to quadrics through two skew lines $L_1$, $L_2$ which may be taken to be $y=mx$, $z=c$; and $y=-mx$, $z=-c$ ($|m|<1$). The system has one degree of freedom and is again composite, breaking up pointwise into two quadratic sub-systems. The axes of revolution corresponding to them are the two reguli on the paraboloid $xy \sin\theta \cos\theta + cz = 0$, ($m=\tan\theta$). There are obviously no cones, but there are 5 members which are doubly degenerate (pairs of planes), of which 3 belong to each sub-system. In each sub-system there are pairs of congruent quadrics, while if $L_1$ and $L_2$ are perpendicular, we have sets of 4 congruent members 2 belonging to each sub-system. The locus of points for which the two quadrics of either system coalesce, is the same rational ruled quadric having $L_1$, $L_2$ for directrices and another double generator at infinity.

It is surprising that when $L_1$ and $L_2$ are conjugate imaginary lines, the quadric system contains neither ellipsoids nor hyperboloids of two sheets—quadrics which one associates with imaginary generators. The reason for this is that conjugate imaginary lines on such quadrics belong to opposite systems and are hence *not skew* unless $L_1$ and $L_2$ are conjugate isotropic lines ($y=\pm ix$, $z=\pm ic$) a case in which the correspondence itself becomes singular as the system contains a sphere whose "axis" is indeterminate.

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### The Biological Oxidation of Carbohydrate Solutions.

USING a percolating filter of special design, S. H. Jenkins (*Biochem. J.*, **27**, 245, 258, 1933) observed that the rate of decomposition of carbohydrates was not influenced by the nature of the nitrogenous compounds that were added, nearly the same amount of sucrose being oxidised per day, in all the cases. There was considerable loss of nitrogen from solutions having C:N ratios of 8·4:1 and 4·2:1 irrespective of the form in which nitrogen was supplied. Experiments with large-scale filters using beet-sugar factory effluents showed that the C:N ratio of the solutions was approximately 20:1 and that the loss of total nitrogen was over 20 per cent. When such filters were supplied with ammonium salts as the source of nitrogen neither nitrite nor nitrate could be detected in the effluent. When the source of nitrogen was mainly organic, no ammonia or any of its oxidation products could be detected. It would appear, therefore, that the liberation of nitrogen from ammonia or different organic compounds of nitrogen occurs entirely within the cells of micro-organisms concerned in the disposal.

The foregoing observations are of much practical significance with reference to the conservation of nitrogen in effluents of the type which the author worked with. The results would not, however, appear to be applicable to either domestic sewage or other forms of industrial wastes which are not so rich in carbohydrate matter.

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### How can Super-conductivity be Explained?

L. BRILLOUIN, in *Comptes Rendus*, **196**, 1088, 1933, has given an interesting discussion as to the manner in which super-conductivity can arise. The curve connecting the energy with the momentum of the electrons in crystals shows discontinuities for certain values of the momentum p, but in general the energy E is an increasing function of the momentum. It can, however, happen in the case of certain crystals with a face-centred cubic lattice—and super-conductivity has been observed only in such materials—that at two symmetrical points A, A′ the curve shows minima. In this case most of the electrons will be in states represented by the rising portions of the curve (which are symmetrical about the energy axis) B, B,′ but there will also be a small number in the states represented by A, A′. The current is given by $\frac{\delta E}{\delta P}$ (R. Peierls, *Eregebnisse der Exakten Naturwissenschaften*, p. 274, 1932). The total current is zero because of the symmetry of the curve giving $\frac{\delta E}{\delta P}$. But if by

some agency as for example, a sufficiently strong electric field, the numbers $n_A$ and $n_A'$ of electrons in the states A and A′ are made unequal, there will be a resultant current. This current will persist for a long time since the electrons cannot go from the state A to A′ or to B since they will then have to pass through a state of maximum energy and at extremely low temperatures the vibrations of the crystal lattice cannot impart the requisite energy to them. If the temperature is increased to the point when the lattice vibrations can give the necessary energy, the superconductivity is destroyed. The fact that the current in a state of superconductivity has a maximum value is explained by the fact that the difference $n_A - n_A'$ has an upper limit. If an electric or magnetic field having a magnitude above a certain limit be applied, the electrons will be made to pass from A to A′ or B and the symmetrical distribution being restored, the super-conductivity vanishes, as is actually observed. Since a thermal gradient cannot take the electrons from one state to another so as to produce the required inequality of $n_A$ and $n_A'$, the fact that there is no thermal super-conductivity finds a ready explanation.

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### Development and Probable Evolution of the Suctorial Disc in the Tadpoles of *Rana afghana* Gunther.

AN examination of a series of larval stages of *Rana afghana* has led Dr. S. L. Hora (*Trans. Roy. Soc. Edin.*, Vol. LVII, Part II, 1932-33, No. 15) to conclude that the evolution of the sucker in *Rana afghana* would be in the same line as that in Garra where a similar disc is found. The disc makes its appearance first in tadpoles of 9 mm. length where it is in the form of a light coloured area along the anterior lower border of the yolk mass. It gradually increases in development and becomes transformed into a fol of skin. The cement organs which are functional till now disappear after the disc is well formed though in some cases the two may co-exist when one is accessory to the other. The disc is essentially an organ developed as a consequence of the rapid streams in which the tadpoles live, necessitating a more powerful organ of attachment than the cement organ.

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### The Positive Electron.

IN *Physical Review*, **43**, 491, 1933, C. D. Anderson described a number of photographs of cosmic ray tracks taken with a vertical Wilson chamber designed by himself and R. A. Millikan, employing a magnetic field of 15,000 gauss. Some of the tracks could only be interpreted as being due to positive particles of the same mass as an electron. All other possibilities that suggested themselves had to be ruled out and the existence of a positive electron was thus rendered highly probable. P. M. S. Blackett and Occhialini (*Proc. Roy. Soc.*, **A. 139**, 699, 1933) were able to secure a large number of photographs of tracks of penetrating radiation by means of a new automatic device which makes the high speed particles associated with cosmic rays start the expansion required for the photographing of their own tracks, and after examining a large number of these photographs they have been led to the same conclusion as Anderson. The existence of positive electrons is predicted by Dirac's theory of the electron, but they are likely to combine with other particles to form nuclei or more probably combine with electrons to be converted into radiation so that they have not been observed in former experiments. According to Blackett and Occhialini the positive electrons might have been produced by the disintegration of neutrons: their occurrence in the experiments of Madame Irene Curie and F. Joliot would then be explicable. These investigators have re-examined their old photographs and taken fresh ones and report their interesting observations in *Comptes Rendus*, (**196**, 1105, 1933). With a magnetic field of 1100 gauss they found 2·83 positive electron tracks and 1·76 doubtful ones for every 10 negative electron tracks coming from the lead sheet used in their apparatus. At 640 gauss they found 4·5 positive electron tracks and 3·6 doubtful ones for every 10 negative electron tracks. When an aluminium plate was substituted for the lead plate, the positive electron tracks dwindled to 0·53 per 10 negative electron tracks, thus showing that the positive electrons came from the lead; when a lead screen of 2 cm. thickness was interposed between the plate and the source of neutrons, the positive electron tracks were reduced to half their original number. Since the neutrons are absorbed by the lead screen only to the extent of 12% while the accompanying $\gamma$-rays are very

much more absorbed, it follows that the positive electrons must have been disengaged from the lead plate by the $\gamma$-rays. This fact supports the hypothesis of Blackett and Occhialini that the emission of positive electrons is responsible for the anomalous absorption of highly penetrating $\gamma$-rays by heavy elements. Gapon (*Zs. f. Phys.*, **82**, 404, 1933), however, explains the anomaly by taking into account the neutrons within the nucleus.

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### Meiotic Phenomena in *Oenothera*.

S. HIDAYETULLAH (*P.R.S.*, No. B 780, Series B, Vol. 113, May 1, 1933) describes for the first time the meiotic phenomena in *Oenothera missouriensis*. In the leptotene the chromatin threads are irregularly running and the threads of the early leptotene gradually concentrate and bend round. The free ends of the folding threads are less in number than the early leptotene stage. The ends approach each other and form seven free bivalent ring pairs in diakinesis. The method of synapsis involved is acrosyndesis (telosynapsis). The nucleolus never attaches itself to the nuclear membrane in the early stages, but later moves and attaches itself to the nuclear membrane and finally disappears in late diakinesis. Reduction division is normal and regular and no non-disjunction of the chromosome pairs has been observed.

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### Leaf-curl in *Zinnia elegans*.

THE above investigation by R. N. Mathur, (*Indian J. Agri. Sci.*, **3**, 89, 1933) presents a unique instance of an insect carrier of a virus disease literally "walking into the net"! The small white-flies (*Bemisia gossypiperda*) which are the vectors of the disease passed the 20-mesh sieve employed by the author and transmitted the infection presumably from without. The disease closely resembles the leaf-curl of cotton: the vector of the infection is also closely allied to the carrier of the cotton disease. As distinct from Kirkpatrick's observations in the case of cotton, the Aleurodids concerned in the spread of the Zinnia disease had to be fed on diseased plant before they became infective.

The investigation was undertaken with a view to throwing some light on the mechanism of insect transmission of the spike-disease of sandal. The latter, however, has so far eluded all methods of insect transmission though readily communicated by artificial infection with the diseased tissue.

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### Permeability of Human Skin.

A. G. R. WHITEHOUSE and Hugh Ramage describe in an interesting article (*P.R.S.*, B.780, 1933)about the permeability of human skin to electrolytes. It is well known that the human skin, besides being a protective investment, acts also as an impermeable membrane for many foreign objects. The authors of the present paper point out that the skin was subjected to the action of a kation like Lithium. When the urine of the subject was tested after the experiment spectrographically no appreciable difference in the Lithium content was noticed. The anion Iodine in the form of KI solution was tried and estimated chemically; no difference in the iodine content was noticed after the experiment. This definitely proves that the human skin is impermeable to electrolytes in simple solutions. On the other hand, un-ionised iodine (in the form of an ointment) is rapidly absorbed by the skin.

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### The Quality Factor in Feeding Stuffs.

IN this paper, J. A. Murray (*J. Agric. Sci.*, **23**, 185, 1933) attempts to define the significance of the highly elusive factor, the quality, and to show its bearing on problems of animal nutrition. The nutritive value of a feeding stuff may be attributed to two factors, 'quantity' as indicated by the gross energy and 'quality' as represented by the coefficient of availability (D/T—0·35) where T is total and D digestible organic matter. The author applies his formula to the results of a number of feeding experiments and draws the conclusion that the nutritive value of the total organic matter depends almost entirely on its digestibility and except in the case of cakes, only to a negligible extent upon its chemical composition. Nutritive value is not proportional to digestibility but a linear function thereof. In substances of low digestibility, slight change in digestibility may cause manifold alteration in nutritive value.

It would be of much interest to extend the above observations to different types of animals, fodders raised on various kinds of soils and manures, and to feeding stuffs made up in diverse ways.

## The Easter Meeting at Bangalore.

UNDER the joint auspices of the South Indian Sciences Association, Bangalore, the Society of Biological Chemists, India, and the Madras Branch of the Indian Chemical Society, a three-day meeting was held in Bangalore during the last Easter Week. The programme commenced on the 15th April with the Presidential Address of Dr. S. Subba Rao, B.A., M.B.C.M., L.R.C.P., etc., Senior Surgeon to the Government of Mysore, when he addressed the gathering on the place of the medical man among the scientists and pleaded for an application of the study of physics and chemistry to the problems of medicine and surgery. This was followed by the reading of several original papers on organic and physical chemistry under the presidency of Dr. P. C. Guha, D.Sc., Professor of Organic Chemistry, Indian Institute of Science, Bangalore. In the evening Sir Mirza M. Ismail, Dewan of Mysore, opened in the presence of a large distinguished gathering, the Sciences Exhibition organized by the Societies. In a felicitous speech Sir Mirza pleaded for a wider study of science in its application to humanity. The precincts of the Central College were *ên fete* and the Mysore Government Electrical Department had flood-lighted the central buildings of the College in honour of the occasion. This exhibition which demonstrated the fundamental principles of Physics, Chemistry, Botany, Zoology, Geology, Medicine and Pathology, Radio, Engineering, Biochemistry, Dairying, Nutrition, etc., was visited by more than 2,500 members of the public during the four days when it was kept open.

On the 16th there was a symposium on the "Ghee Problem in India" under the presidency of Dr. S. Subba Rao when the following papers were read and followed by an interesting discussion :*—

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| Dietetic value of ghee | Mr. N. C. Datta and Mr. B. N. Banerji. |
| Adulteration and Analysis | Mr. Y. V. Srikanteswaran. |
| Ghee substitutes, their manufacture and trade | Dr. R. Bhattacharjee. |
| Chemical aspect | Mr. P. Ramaswami Ayyar. |

In the evening Rao Bahadur R. Viswanath, F.I.C., Government Agricultural Chemist, Coimbatore, delivered a public lecture on Plant and Animal when Sir C. V. Raman, Kt., F.R.S., N.L., presided. He said that the plant and the animal in their co-operative existence in nature bring about the marvellous round of events in which the inorganic is shaped into the organic which, passing through successive changes and displaying manifestations of life, pass again into the inorganic state only to resume the organic form. In this round of events he referred to the wonderful power of plants to build up their tissues from simple substances, and contrasted this with the helplessness of animals to utilize the same substances till they are made ready into a more suitable form by plant agency. He pointed out that although the structure and functions of the body parts of plants and animals have little in common, the recent contributions made to the biochemistry of plant and animal show that many of the typical functions of the cell are capable of being expressed in terms of simple chemical formulae or equations, leading ultimately to the simplification of phenomena and to the view that in its fundamentals the physiological mechanism of the two organisms is similar. From the epoch-making work of Willstatter and his collaborators similarity and relationship is visible between the vital centres of plants and animals, through their pigments chlorophyll and hæmoglobin from both of which ætioporphyrin can be obtained. Likewise instances were shown in which considerable similarity is revealed in the chemical changes underlying the metabolic and katabolic processes. While recognizing that analogics should not be stretched too far, the available evidence would justify consideration of the plant in terms of the animal in certain directions, and the lecturer showed how on the basis of such considerations it is possible to use the plant as an index or test organism in the solution of certain problems connected with animal life, such as nutritional, immunological and pharmacological studies.

On the 17th Dr. V. Subrahmanyan, D.Sc., F.I.C., Professor of Biochemistry, Indian Institute of Science, Bangalore, presided over the reading and discussion of original papers of biochemical interest. Dr. Gilbert J. Fowler, D.Sc., F.I.C., addressed on the Ern and Technocracy under the presidency of Prof. C. R. Narayan Rao, M.A., L.T.*

There was a number of delegates from Coimbatore and other places who contributed largely to the success of the Session.

* See page 400.

* Summary of this address has appeared in *Current Science*, **1**, 11, 366, 1933.

## The Ghee Problem in India.

THE Ghee Problem in India was the subject of a symposium held under the joint auspices of the South Indian Sciences Association, Bangalore, Society of Biological Indian Chemists (India) and the Madras Branch of the Indian Chemical Society, at Bangalore on the 16th April. The following papers were contributed :—

MR. B. N. BANERJI : "*The Metabolism of Fat.*"—From the physiological point of view, ghee is a mixture of true fat, *i.e.*, glycerides of fatty acids, lipoids like lecithin and cephalin containing nitrogen and phosphorus in combination, and the unsaponifiable sterols. In the animals two types of fats are distinguished—the tissue fat and the reserve fat. The former is uniform in composition while the latter depends on the diet. Fats from different parts of the body differ considerably in composition and consistency. Tissue fats are more unsaturated than reserve fats. The fats function an important rôle in metabolism. They yield the highest caloric energy and their ability to be stored up in large quantities makes them a convenient form of reserve food for the organism. They serve also as good insulators against temperature changes. Fats are an essential item of food and carriers of vitamins and other growth-promoting factors. Growth cannot be obtained on an entirely fat-free diet. Fat is digested in the intestines after emulsification by the pancreatic lipase. Most of the fatty acids are converted into soaps which are absorbed in the mucosa. They then pass into blood through the lymphatics. One to three hours after food the blood fat rises reaching its maximum in 6 to 7 hours after which it returns to normal. The oxidation and disposal of blood fat is obscure. The liver where desaturation takes place is the most important organ in fat metabolism. Apparently, all fats can be synthesised in the body, and proteins and carbohydrates can produce fat. But whether all the fatty acids can be synthesised is not known. Addition of linoleic acid to fat-free diet cures deficiency but not the addition of saturated acids. Linoleic acid therefore is not synthesised in the body. Fat excretion is fairly constant 5 to 10% being absorbed ; there is no fat in urine, very little in sweat and the greater portion is excreted in the fæces. Age, sex, heredity, disturbance of endocrine glands, gonads and pituitary, alter the deposit of the fat pattern. However, there is no disturbance of fat metabolism in obesity. The factors that cause disturbance in blood fat are very meagrely understood. Blood is apparently a system for transportation, and many confusing notions are extant. The real metabolism of fat, the lipoids and sterols is not fully known, though their importance as an essential item in cell function and transportation is undeniable.

Lipoids are definite constituents of protoplasm. They act as carriers of fats in utilization by the cells. Lipoids are synthesised in the body from inorganic phosphorus. The sterols, cholesterol of animals and phytosterol of plants, are also important constituents of all protoplasm. Their importace in cell membrane functions and as carriers of vitamins are well known.

* * *

MR. N. C. DATTA : "*The Dietetic Value of Ghee.*"—The adulteration of milk products like ghee and butter is of recent origin in India. The introduction of vegetable ghee has made the problem of getting pure ghee rather difficult. Enormous quantities of vegetable ghee manufactured in India and also imported from other countries are used for adulteration purposes. Owing to lack of proper enforcement of the Foods and Drugs Adulteration Act, the adulterated ghee trade is flourishing very well. From the dietetic point of view, as a glyceride of fatty acids, in calorific value, vegetable ghee is equivalent to pure ghee but in contrast to other fats, pure ghee has certain peculiar properties, namely, low melting point and high emulsifying power. Many vegetable ghees are not so easily emulsified and melt at a temperature much higher than the body temperature, so that their use can be held objectionable on the contention that they will be less digestible than pure ghee. Ghee prepared by melting pure butter contains vitamin A and is found to be quite as good as pure butter, whereas the hydrogenated oils contain little or no accessory food factor so that vegetable ghee has not as good a nutritive value as pure ghee. Pure ghee and vegetable ghee sell almost at the same price in many parts of India so that the use of vegetable ghee does not hold good even on economical grounds.

In cities like Madras, Calcutta, Bombay, where milk and vegetables containing vitamin A are expensive, the poor and the middle class people are subsisting on the border of their vitamin A requirements. According to Sir McCarrison the diet of the people of Madras and Bengal are usually poor in vitamin A, so that the use of vegetable ghee will certainly affect the health of the people. Particular classes in certain cities, a few families everywhere and numerous individuals throughout the country suffer from a deficiency of vitamin A through the neglect of the use of milk, butter and ghee. The high rate of mortality, the ill-health of young mothers and incidence of diseases like tuberculosis clearly indicate the want of proper nutrition among the people of India. It is highly desirable from the physiological point of view that greater consumption of milk in the country should be encouraged.

India is essentially an agricultural country whose fertile soil and climatic conditions, particularly favourable for the growth of grass, make dairying a household industry well adapted for the country. Proper education among the farmers, and the use of plenty of green grass and sunshine enriching the milk with more of vitamins A and D, will offer the greatest promise to further development of Dairying in India.

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MR. Y. V. SRIKANTESWARA IYER : "*Adulteration and Analysis of Ghee.*"—It is to be deplored that in India there are no satisfactory standards of supply of food materials. Most of the countries abroad have laws in accordance with which the sale of impure or adulterated foods is made a criminal offence and many are provided with public Analysts and other officers to enforce these laws and punish the offenders. The importance of legal control of such commonly used articles of food as milk, butter, ghee and various kinds of edible oils, etc., cannot be over-emphasized. So far, their manufacture and sale have not been legalized

in our country and it has afforded great opportunity for the growth of fraudulent trade.

The practice of adulterating food materials is comparatively of recent origin in India. There are two kinds of adulteration in practice. The scientific manner practised mostly in the Western countries and the non-scientific one that is generally prevalent in India. The non-scientific adulteration is easily detectable and therefore an efficient check, if exercised over the sale of the food materials, would completely efface this vicious practice. With the advent of the oil hardening industry and the establishment of factories for the purpose in some parts of India, there has been a great stimulus given to this kind of adulteration in oil trade which has been responsible in baffling the Analysts engaged in detecting these adulterations.

With respect to ghee, which is nothing but pure milk fat, the problem of adulteration is of great concern to our nation. The detection of adulteration of ghee has been the subject of many investigators. The common adulterants that one comes across in India are some of the local edible oils like groundnut, sesame, cotton seed and the cocoanut, which are capable of being easily detectable by ordinary physical tests alone. But with the introduction of the refining, bleaching, de-odouring, hardening and flavouring methods for oils, one finds these adulterants incorporated in such a scientific manner that it has complicated the problem of their detection to a very marked degree. In addition to these local adulterants, "lard" of different grades is well incorporated with butter fat or at times is itself flavoured with artificial butter aroma and sold under the name of pure butter fat. It is, however, well known that it is only pure milk fat that contains fatty acids of a soluble and volatile nature in considerable quantity that possess the property of easy emulsification and digestion in the human system. All other fats fail markedly in this respect. Perhaps it was on account of this feature of milk fat that the superiority of the use of butter was recognized in India. The various substitutes like oleo-margarine, margarine, butterine, commonly used in the West and other similar products but containing lard, etc., while supplying the required heat units to the body do not do so with so much of ease and benefit as butter fat. Besides, instances have not been wanting to show that these products have had very baneful effects regarding the digestion on those that consumed them.

The analysis of oils and fats being the most difficult branch of analytical chemistry, the analyst is faced with innumerable difficulties in the absence of specific standards. The Western standards that are in vogue, in many instances, are wholly inapplicable to Indian products. Therefore, the necessity for the establishment of standards based on the results of a thorough investigation is keenly felt by many workers. Unless the Government and the well-established scientific institutions take up this piece of work, it is impossible to expect a better future for the supply of pure food materials on which only depends the health of our nation.

The methods commonly adopted for the analysis of ghee are mostly empirical. With a careful handling and strict adherence to the technique of the methods one could arrive with difficulty at the purity or otherwise of the sample in question. The chief factors that throw light on the purity or otherwise of the sample of ghee are refractive index at 40°C (42 to 44), saponification value (230 to 240), iodine value (30 to 35), R. M. value (20 to 30) and soluble fatty acids (3.5 to 4). The origin of the fat can fairly be established by performing the well-known "Phytosterol Acetate test" where the melting point of the substance determines whether it is one of animal or vegetable or a mixture. The usual value of the melting point obtained for the "Cholesterol" Acetate is 113·5°C to 114·5°C showing animal origin and for the Phytosterol Acetate, 127°C and 133°C showing vegetable origin. There are other colour tests, too, which are resorted to at times and which prove very helpful.

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MR. P. RAMASWAMI AYYAR: "*The Chemical Aspect of the Ghee Problem in India.*"—From the Chemical standpoint "Ghee" is rather a vague term. It may be the milkfat of the cow or the buffalo, or, in rare cases, that of other animals like goat, sheep, camel, etc. These milkfats differ markedly in their properties; for example, at the ordinary temperature of 25°C, goat's ghee is a liquid, cow's ghee is semi-solid, and buffalo-ghee quite solid. These differences are due to the varying chemical compositions of these fats; thus, goat's ghee consists of a large proportion (above 10%) of the easily digested glycerides of the lower fatty acids, butyric, caproic, caprylic and capric and only a small proportion of the difficultly digested high-melting glycerides of palmitic, stearic and arachidic acids; whereas buffalo-ghee contains under 5% of the lower glycerides and over 50 per cent of the high-melting glycerides; while the composition of cow's ghee is intermediate in character. Most of the common edible fatty oils, like gingelly, groundnut, mustard and safflower oils do not contain any lower glycerides but are chiefly composed of the liquid glycerides, oleic and linolic acids with varying proportions of the high-melting glycerides of palmitic, stearic and arachidic acids; the only exception being cocoanut oil which contains up to 20 per cent of the lower glycerides. The value of cow's ghee as an article of diet of the Indian intelligentsia is a matter of experience; and in the absence of definite knowledge of the exact manner in which the various glycerides of cow's ghee are utilized by the human organism for its metabolic and energy requirements, it will be unsafe to put on the market, any synthetic fatty product resembling ghee, as ghee substitute, without chemically ensuring that it contains all the glycerides present in cow's ghee.

Most of the ghee-substitutes on the market are, unfortunately, made from hydrogenated groundnut oil or similar products. Actually hydrogenation destroys the liquid linolic glyceride converting it into that of a solid isoleic acid which is more difficultly digested and more prone to rancidity than oleic acid; further, much of the liquid oleic glyceride is converted into the high-melting stearic glyceride, producing, on the whole, a ghee-like fat but entirely lacking in lower glycerides and in linolic acid. These chemical deficiencies in ghee-substitutes may lead to serious deficiency diseases as has recently been demonstrated in the case of rats by the work of the Burrs during 1929 to 1932 (*J. Biol. Chem.*, Vol. 82, 86 and 97). Any ghee-substitute should, therefore, contain the essential components of cow's ghee along with

appreciable amounts of linolic glyceride. It is also advisable to ensure absence of all iso-oleic glycerides. Any oil-chemist can easily manage the production of such a ghee-substitute.

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DR. R. BHATTACHARJEE: "*Ghee Substitutes, their Manufacture and Trade.*"—The manufacture of artificial ghee has called for a large amount of research. Started as a war measure, margarine has taken a good place as butter substitute in Europe. In a poor country like India, where increase of population has led to encroachment on grazing lands, the price of a dairy product like ghee is very high and beyond the means of many. In towns it is very difficult to get unadulterated ghee, and most of the products are grossly adulterated with vegetable and animal fats that are positively harmful as food. It is always better to consume a standard, pure and refined substitute than a product adulterated with unknown and undesirable constituents mixed up by ignorant and unscrupulous traders. As such the production of a good substitute, artificially made, is an important problem. The manufacture of artificial ghee requires four distinct operations, namely, the preparation of the base, refining and de-odourising, hydrogenation and blending or developing the ghee odour. The preparation of the base necessitates a very careful mixing of the edible oils, like cocoanut, groundnut, sesame, etc., to make up the constituents as near to that of ghee as possible and great ingenuity is called for in the preparation of such a base. Well tried edible oils can be safely used in the preparation of the base. Oil chemists and technologists are busy in the making up of such a base. The process of refining and de-odourising has necessitated a high standard of technological operation. The product has to be made water white in colour absolutely odourless, and this requires the use of the best grade of oils. Again the acidity has to be brought down to as low a figure as 0·02% for hydrogenation. Naturally in hydrogenated fat we have one of the best refined fats possible. The process of hydrogenation gives us a product that is equal to the best samples of ghee in appearance and consistency. After hydrogenation the product has the same psychological value as any ghee on the consumer and his digestion. Finally, blending of the ghee odour requires the highest skill. Harmless odours are added, or the odour is developed biologically and then blended in the finished product with some suitable base. It cannot be said that the problem is solved because there are still a number of points to be tackled. There are four big factories in India that produce hydrogenated oils and besides a large amount of artificial ghee is imported from Holland which is the pioneer in this line. Time alone will determine the value of these substitutes on the health and future of the race. Digestibility and the question of vitamins A and D content have to be borne in mind. The researches of Windaus, Steenbock and Drummond have solved the question of vitamin D and it is hoped that the presence of vitamin A also will be ensured at an early date.

K. S. VARADACHAR.

## Science News.

*Chemical and X-ray Studies in Tertiary Coals.*—DR. C. MAHADEVAN, Assistant Superintendent, Hyderabad Geological Survey, writes that chemical and X-ray investigations were carried out with tertiary coals of the same geological age and horizon ranging from peaty lignites to anthracites. Chemical analyses of the coals indicate that in coalification, the degradation of the cellulose of the vegetable matter is at first rapid and the lignin is more resistant, in conformity with the generally accepted views; but after a certain stage, the destruction of cellulose seems to proceed at a much slower pace while that of lignin is more rapid. The presence of small amounts of cellulose in coals (as represented by Makerwal and Mach specimens) is an interesting result in this study.

Lignins were isolated from the coals by digestion with alkali and purified. The X-ray pattern of all these lignins are practically identical and resemble the pattern for flax lignin. On a comparison of the X-ray patterns for the untreated flax and its lignin, it is seen that except for the observation of fibrous nature in the untreated flax the halos in the two cases show great similarity.

In the case of lignite from Palana, the end residual products after alkali autoclaving and acid treatment give X-ray patterns very similar to the 'gamma compound' pattern of coals.

The X-ray patterns obtained with the peaty lignites and lignitic coals in the untreated state consist of two halos, one intense and the other somewhat fainter, the corresponding spacings for the two groups being 3.59 Å.U. (intense), 2.43 Å.U. (faint) and 3.5 Å.U. (intense) and 2.23 Å.U. (faint) respectively. The anthracitic coals give quite a different pattern showing unmistakable indications of free carbon in fairly coarse state. The spacing for the tertiary coals, *viz.*, 3.5 Å.U., are distinctly different from the corresponding values, *viz.*, 3·39 Å.U., for permocarboniferous coals, in spite of apparent similarity of the composition as determined by "proximate analysis". These observations are discussed in relation to the geological history of the coal fields from where the specimens were obtained and in relation to the Bergius' theory of coal formation in nature.

It is seen that in conformity with the field observations, the X-ray patterns show progressive alteration to anthracitic stage with increasing pressure. The Palana lignites which have not been subjected to much pressure show larger spacings for the halo similar to a pattern for peat; the next set of coals,—Mach and Makerwal—have been subjected to moderate pressure and they correspond closely to the normal tertiary coals studied from other horizons. The anthracitic coals which are from a region of great tectonic activity give patterns characteristic of free carbon and mineral matter.

The distinct difference between the X-ray patterns of the tertiary and the upper palæozoic coals, especially the higher spacings for the former in spite of their similar "proximate composition"

points to a less compact structure of the fundamental coal substance in the tertiary specimens. The palæozoic coals seem to have reached the final stage of maturity. In normal palæozoic strata, anthracitic coals are absent. The existence, however, of anthracites in highly folded regions is attributed to the great pressure to which these regions had been subjected. The results of the X-ray study are in conformity with the above observations and support the Bergius' theory of coal and anthracite formation in nature. A detailed paper on the subject is under publication elsewhere.

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We have received a copy of the Annual Report of the Inter-University Board, India, for the year 1932–33 which details a record of the useful activities of the Board. The Board has continued its exertions to bring about a closer co-operation between the several Universities in the country by mutual recognition of the degrees conferred by each University and also by trying to maintain the same standards of efficiency throughout. We note with pleasure that, during the year under review, an attempt was made by the Board to co-ordinate the research work done at the different Universities which was met with a certain amount of success. We hope the Board will pursue this matter in greater detail and bring about a better understanding and closer contact among the individual research workers. The chapter on the introduction of Military Science as a subject of study in Indian Universities makes interesting reading. We regret to note that the Government of India have not come forward with that co-operation which might have been expected of them in this matter and as such the discussions have not led to any tangible result. We trust that the subject, which is promised to be discussed at the February meeting of the Board, will be taken up in earnest and a useful syllabus drawn up and that everything will be done to secure the full assistance of the Military authorities to successfully carry out the task.

The proposal of the Board to have a Central Advisory Board of Scientific Research was considered by a Committee appointed for that purpose with Sir C. V. Raman, F.R.S., N.L., as chairman who reported that general conditions were not propitious for the inauguration of such a scheme. We will discuss this subject at greater length in our editorial columns at an early date when we will have more to say on this matter. Meanwhile we are glad to note that the idea has been in the minds of several persons so that when a scheme is put forth it will receive wide and careful consideration.

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The Imperial Bureau of Plant Genetics, School of Agriculture, Cambridge, England, have issued a Bibliography on the Breeding and Genetics of the Millets and Sorghums. The pamphlet contains a summary of the work done in Sorghums and Millets up to 1932 and contains 81 references listed in the alphabetical order of the authors' names. We are sure that all interested in this field of work will find this pamphlet, which can be had at a cost of 1s., a very useful reference.

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Mr. P. C. Biswas, M.Sc., Research Student, Anthropological Laboratory, Calcutta University, who has been studying the group Mal-Paharias and other allied sections of people, finds that the distinction between Mal-Paharias and Sauria Paharias is real and should not be minimised as has been done by Mr. S. Sirkar in his recent note on these people published in April number of *Current Science*. In the course of his investigations in the field, Mr. Biswas was unable to discover even a single case of intermarriage of Saurias. From the data that he has collected, he makes out thirteen clan names instead of eleven given by Mr. Sirkar and the names Ghuns and Pughor given by the latter writer are not supported by Mr. Biswas. He finds that the kinship terminology collected by him shows a strong Hindu influence and at least so far as present conditions are concerned, the descriptive nature of terminology is quite in accord with the absence of primitive forms of the dual organization such as is met with among the Aimol Kukis of Manipur.

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The Hon. Secretary, the Indian Chemical Society, 92, Upper Circular Road, Calcutta, announces that Prof. S. S. Bhatnagar has awarded a medal in commemoration of the Seventieth Birthday of Sir P. C. Ray, for the best single original contribution on any branches of Chemistry, published in the *Journal of the Indian Chemical Society* by an Indian Chemist of age not exceeding 30 years. The medal will be awarded every year.

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The Sir Prafulla Chandra Ray Seventieth Birthday Commemoration Volume of the *Journal of the Indian Chemical Society* has just been published and contains articles on various branches of Chemistry, contributed by eminent Chemists of India and abroad. The price for Fellows is Rs. 3 and for non-Fellows Rs. 5. Copies can be had of the Secretary, Indian Chemical Society, Calcutta.

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*The Indian Association for the Cultivation of Science.*—We have pleasure in congratulating Prof. K. S. Krishnan on his election to the Secretaryship of the Association and on his appointment to Mahendra Lal Sircar Professorship of Physics. The creation of a permanent professorship at the Association is a notable event in the progress of Science in India and the appointment of Professor K. S. Krishnan who has been closely associated with Sir C. V. Raman in his work is a happy augury of the steady progress of work in the Institution.

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The Ninth Congress of the Far Eastern Association of Tropical Medicine will be held at Nanking, China, from 2nd to 8th October 1933. All licensed medical, dental and veterinary practitioners are eligible for membership. Members are privileged to attend and take part in the meetings and to present original papers. Further information relating to the Congress can be obtained from the Local Provincial Secretaries or from the Local Secretary, Government of India, Kasauli, Punjab, or the Hon. General Secretary, Far Eastern Association of Tropical Medicine, Batavia-Centrum, Java.

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We acknowledge with thanks the receipt of the following:—

"Nature," Vol. 131, Nos. 3312 to 3314.

"The Chemical Age," Vol. 28, Nos. 720 to 723.

"The Journal of the Annamalai University," Vol. 2, No. 1, April 1933.

Minutes of the Convocation, Academic Council, Senate, Syndicate of the University of Madras.

"Canadian Journal of Research," Vol. 8, No. 3.

Bulletin of Applied Botany of Genetics and Plant Breeding of the Institute of Plant Industry, The Lennin Academy of Agri. Scs., Lenningrad, U. S. S. R., Second Series, Nos. 1 and 3.

"Scientific Indian," Vol. IX, No. 52, April 1933.

"Journal of the Indian Chemical Society," Vol. 9, No. 2, Feb. 1933.

"Transactions of the Royal Society of Edinburgh," Vol. LVII, Part II, No. 15, 1932-33—Development and Probable Evolution of the Suctional Disc in the tadpoles of *Rana afghana* Gunther—by Sunder Lal Hora.

Memoirs of the Indian Museum, Vol. XII, No. 2, pp. 263-330—Classification Bionomics and Evolution of Homalopteroid Fishes—by Sunder Lal Hora.

Goboid Fishes of Torrential Streams, by Sunder Lal Hora.

Buchanan's Ichthyological Manuscript entitled "Piscium Bengalæ Inferioris Delineationes" by Sunder Lal Hora.

Report on the Administration of the Government Museum and Public Gardens, Trivandrum, for the year 1107 M. E.

"The Quarterly Journal of the Geological, Mining and Metallurgical Society of India," Vol. IV, No. 4, Dec. 1932.

Communications from the Physical Laboratory of the University of Leiden, Nos. 205 to 216.

"Journal of Agricultural Research," Vol. 46, Nos. 4 and 5, Feb. and March 1933.

State College of Washington Agricultural Experiment Station, Pullman, Washington. Bulletin 277—Trends in the Apple Industry, by Chester C. Hampson.

Bulletin No. 278—The Production and Utilization of Corn grown under Irrigation in Washington, by H. P. Singleton.

"Journal of the Indian Chemical Society"—Sir Prafulla Chandra Ray Seventieth Birthday Commemoration Volume.

"Natural History," Vol. 33, No. 3, May-June.

The Nagpur Agricultural College Magazine, Vol. 7, No. 4.

"Berichte Der Deutschen Chemischen Gesselschaft" 66 Jahrg, No. 5, 1933.

## Reviews.

ATOMS AND COSMOS, THE WORLD OF MODERN PHYSICS. By Hans Reichenbasch, Professor of Natural Philosophy, University of Berlin. English Translation by Edward S. Allen. (George Allen & Unwin, Limited, Museum Street, London.)

The revolutionary character of some of the fundamental concepts of Modern Physics has excited the curiosity of the ordinary educated man with no special knowledge of Physics. To allay this curiosity a large number of books have been published with the sole object of making these ideas intelligible to the non-specialist. Among such books a prominent place must be given to "Atoms and Cosmos" by Hans Reichenbasch. The book is based on the lectures which the author broadcast during the winter of 1929-30. After an introduction in which is stressed the point that it is possible to indicate the general trend of scientific progress to the layman without the usual machinery of mathematical investigation and formulæ, the author treats problems relating to Space, Time and the Special Theory of Relativity. In the next section comes for treatment, the Special Theory. We can safely say that the author has succeeded in his attempt to make these obstruse subjects intelligible to any one who takes pains to read carefully the words of the author, though such a reader may be unacquainted with Physics. Radiation and Matter, Radioactivity and related topics are next considered and receive a clear non-mathematical modern treatment. In Section 17 an attempt is made to give to the layman an idea of the wave character of matter which we owe to de Broglie and Schrödinger and of the work of Heisenberg and Dirac. It is doubtful, however, whether one who is not familiar with Modern Physics can really understand to any extent, by reading the book, the subjects treated in this section. If the reader finds any difficulty, the nature of the subject and not the author is to blame.

The vexed question of causality in relation to probability is taken up in Section 18. According to the author, Heisenberg's uncertainty principle sets up such barriers to advance calculation in atomic phenomena that even the Laplacian superman cannot pass. 'Nature is simply not completely determined.' As against this we may quote the words of Max Planck from his recent book *Where is Science Going*, 'And I have not been able to find the slightest reason to

give up the assumption of a strictly law-governed Universe'. One who carefully reads this recent book of Planck is impressed with the arguments he puts forward in support of his view that the law of causality must be taken to hold strictly in the entire world of physics.

In conclusion we strongly recommend this excellently written book to every one desirous of getting a general idea of Modern Physics in non-mathematical terms.

B. V.

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AN INTRODUCTION TO THE CALCULUS. By G. Van Praagh. (Macmillan.)

A student of physics or chemistry often asks a mathematician to suggest a book on the calculus which satisfies his requirements and which is at the same time as concise and free from elaborate analytical theory as possible. For such students, this new book is likely to be useful. The mechanical processes of differentiation and integration are briefly but lucidly explained, and a number of applications to physics and chemistry are given, including a chapter on the determination of centre of gravity and moments of inertia. There are also short chapters on maxima and minima, partial differentiation, and differential equations, but the reviewer feels that these chapters ought to be slightly enlarged and should contain some examples by way of drill. The utility of the book will thereby be greatly increased, and will meet more satisfactorily the requirements of the physicist and the chemist. As it is, the book will be welcome to the general science student.

C. N. SRINIVASIENGAR.

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THE MEANING OF ANIMAL COLOUR AND ADORNMENT. By Major R. W. G. Hingston, M.C., M.B. (Edwin Arnold & Co., London, 1933.)

Charles Darwin put forward the theory of sexual selection to give a scientific explanation of the fact of beauty in organic structures. It is a matter of common observation that the higher animals exercise discrimination in the selection of those individuals of the opposite for mating which, in their eyes, are superiorly endowed with colour ornamentation, offensive weapons or other capacities for emotional expression. It is usually inferred from these observed facts, that the animals which do not pair indiscriminately possess an æsthetic sense and because selection is influenced by artistic taste, the cause is sufficient to explain the phenomena of beauty among animals. The theory of sexual selection is entirely different from the theory of natural selection; the former deals with an explanation of the gorgeous, decorative and life embellishing structures which occur in one of the sexes in a more marked degree. The sexes differ not only in respect of their colour adornment, but also in respect of size, strength and the possession of weapons. It is an observable fact that these weapons, mostly confined to male members, are perfected at the time of maturity and are used in securing possession of the females by fighting with the male rivals. Darwin recognized in these mating contests the principle of the Law of Battle between the males of the same species and this principle forms part of the theory of sexual selection. It is true that in operation this principle of fight for possession is not sharply marked off from that involved in the struggle of animals for possession of territories, food and other natural advantages for continued and exclusive existence. In fact, the Law of Battle implied in the theory of sexual selection is as expressive of brute force and calls for the exercise of the very weapons which are involved in the explanation of the origin of the structures of utility. It is also to be recognized that the wealth of evidence accumulated in support of the sexual selection theory is not so overwhelming and convincing as that in support of the theory of natural selection. However, "the surprising uniformity in the laws regulating the differences between the sexes in so many and such widely separated classes is intelligible if we admit the action throughout all the higher divisions of the animal kingdom of one common cause, *viz.*, sexual selection." Wallace's views upon the subject and H. E. Howard's objections are well known.

Major Hingston's book has the rare merit of appealing at once to the specialist and to the general reader and represents a large wealth of information on animal habits in their natural environment. He has put forward an ingenious explanation of colour adornment, the songs, moults, offensive weapons and courtship, and the book is intended to be an exposition of the theory which he calls "Colour Conflict". The theory "asserts that every animal possesses two patterns of colour, one for concealment and one for war. Both patterns are important to it; the one in order to hide it from

enemies, the other in order to defeat its rivals. These two patterns are contending with each other and the colour of the animal is the result of that contention. It is partly concealing and partly threatening It cannot become more threatening without losing some of its concealing pattern. It cannot become more concealing without losing some of its threatening pattern. It is thus kept in a stable colour-state by the organic and inorganic influences that surround it. In the wild state it cannot deviate much from this stability without exposing itself to greater danger and in consequence being weeded out." This is the fullest implication of the new theory, which we may state at once is too defective to be a complete refutation of the theory of sexual selection or to replace the theory of natural selection.

As an illustration of his hypothesis, he takes the lion whose intimidating gestures include the spreading of his mane, the whisking of his tail above his back and drawing back his ears. These parts of the body bear the conspicuous black colour which is a menacing colour and the tawny background forms a concealing colour. In other words, the lion has a protective colour, superimposed on it there are threatening dark coloured patterns. From this circumstance Major Hingston argues that, movements of tail, the presence of beards or mane or ruffle and even non-hairy coloured patches of skin among mammals have the same significance. It is true that all cats move their tails when in anger, but they also whisk their tails sideways or tuck them up and erect their hair when they show affection; it is true that deer when alarmed put up their tail exposing the white undersurface, but they do just the same to express their joy at the sight of food and when engaged in courtship; it is true that the crimson callosities of baboons are wide and if, according to Major Hingston, they are used in intimidating their rivals, they should face back to back in their contests, but do they do so? Among the Ungulates, the tufted tail is erect above the back not only when two-hoofed animals fight, but also when they frisk about in exultation, when they butt against earth mounds in sheer excess of joy and when the calf sucks the udders of the cow. The author's ingenuity is remarkable when he attempts to explain the significance of hair in the axilla and pubis of man which he regards has the menacing value of the mane and tail of the lion. Primitive man not only fought but danced with uplifted arms and the hair in the axilla is exposed during nuptial embrace as well. The explanation of pubic hair as given by Major Hingston appears to us rather fantastic. We believe that its significance is to evoke and excite consciousness of sex. The presence of such hair in the two sexes does not lend support to the theory of colour conflict. If the greying of human hair is a sign of the loss of fighting qualities, it also signifies the cessation of man's reproductive powers. Major Hingston goes to the length of suggesting that the deeper pigment of the male human being is a threatening colour as contrasted with the lighter hue of the females at least among the East Indian races though not among the Europeans. If so the lighter European male members are less pugnaceous than the darker Indian races and are the women among the working classes lighter than their husbands and brothers? We have read the book from cover to cover and while we have derived much profit, we confess we have also derived much amusement. Those who are nurtured on the milk of Darwinism will hesitate to accept the conclusions of the book and the main reason is that Major Hingston does not recognize the fundamental fact that secondary sexual characters have an emotional, significance possessing both life-saving and life-embellishing values. Animal emotions including those of man are easily translatable one into the other and nature exercises economy in endowing the animals with structures and colour patterns for their expression. Thus the vocal organs of the crow, for instance, are adapted for expressing fear, defiance, mockery, anger, love, alarm and joy and it would be a narrow one-sided view to take if we postulate that the voice of all animals has the psychological significance of a call for battle. Major Hingston is not wrong in seeing threat in the tails, long hairs, songs, moults, and tusks and similar structures, including even the spurs and colour patterns of birds, but that is not the entire and comprehensive view to take for purposes of a generalization in the form of a theory. Nevertheless, we have pleasure in recording that the book is an excellent production which will fascinate the lay-reader by the wealth of interesting information which the author has marshalled in support of his theory. We believe that the specialist will be disposed to make marginal notes and queries as he reads through the book. As a

book on natural history of animals, the book is entitled to high praise, though its contribution to the philosophy of biological science may not be regarded as of first rate importance.

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HEARING IN MAN AND ANIMALS. By R. T. Beatty, M.A., B.E., D.Sc. (George Bell & Sons, Ltd., London, 1932.)

The purpose of this very interesting book, according to the author, is to provide in simple terms the general reader with a clear and connected account of the acoustic phenomena in animals including man and of the various sensory mechanisms by which they are rendered conscious of the range of sounds which are important for their welfare. The book is an exceedingly neat illustration of the fact that researches carried on in different departments of knowledge give little impression of their value unless they are correlated into a homogeneous concept in the interpretation of the vital phenomena of living organisms. In his studies of the structure of the ear and its functions, the author has drawn freely from the investigations of anatomists, physiologists, physicists, engineers and psychologists and the result is a compilation of interesting facts which give a coherent picture of the organ of hearing.

In the first two chapters are treated the structure and evolution of the different parts of the ear. The study of the development of the auditory ossicles of the mammalian middle ear and of the cochlea in birds and mammals is an important part of the study of comparative morphology and the account of their formation is in accord with the researches in embryology and palæontology. That certain bony elements of the lower jaw of reptiles shift from their position and enter into relation with the auditory organ of the mammals is a fact of profound evolutionary significance. The chapters on the resonance theory of hearing and sensations of hearing are physical and the mathematical portion is dealt with in a manner which can be understood even by those who have not the benefit of training in this branch of science. The account is complete, clear and correct. The physiological part of the function is treated in the subsequent chapters with equal clarity and precision. The section on noise has an importance to the general public and the administrators, which in our judgment should be read by them and understood in its manifold bearings.

We have read this little book with deep interest and the description of the structure and evolution of the organs of hearing in animals ranging from the insects to man provides a fascinating and profitable study. The great merit of the book is that it has dispensed with the horrible technical terms peculiar to the several sciences whose researches are made use of in the treatment of the subject, but without sacrificing scientific precision and logical deductions from the facts of researches. The book is a valuable contribution to the science of the physiology of sensory organs useful alike to specialists and to the general readers among whom we include legislators.

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ECOLOGY OF THE FAUNA OF THE SALT RANGE, PUNJAB.

To the students of animal distribution and ecology the fauna of the Salt Range, Punjab, presents several features of great interest. For a number of years the animal life of this hot and dry tract, with peculiar conditions of the soil, was known from casual observations and collections made through the efforts of the earlier geologists Theobald and Waagen, in the course of their geological explorations. In 1922-23, however, the Zoological Survey of India made faunistic studies (*Rec. Ind. Mus.*, **25**, 365, 601 1923) of this region, and even then attention was mainly directed to the cold-blooded vertebrates and molluscs. It is a matter of great pleasure, therefore, that in the recent issue of the *Records of the Indian Museum* (pp. 87-119), Dr. H. S. Pruthi extends our knowledge of the aquatic animal life of this area by making "An Ecological Study of the Fauna of the Khewra Gorge and some other salt waters of the Salt Range, Punjab". He not only brings home to us the varied nature of the aquatic fauna, rich in insects, but also indicates, in a masterly way, the conditions of the peculiar environment to which the animals have become adjusted, evidently by a process of gradual colonization The physical and chemical factors of the environment are analysed, but unfortunately it is not indicated whether any structural modifications have resulted from the adaptation of animals to these very adverse conditions of existence. In concluding the article, Dr. Pruthi refers to the interesting question of the colonization of the sea by insects, and makes a tentative suggestion that, in all probability, the insufficiency of calcium is

the inhibiting factor, for he found the insect-fauna very rich and varied in the waters of the Khewra Gorge which had a large amount of calcium in solution.

Even a cursory perusal of this interesting article shows the great range of adaptability to changes in salinity that is exhibited by the fauna, and also the plastic nature of the animals, which become moulded, presumbly in course of time, structurally (?) or at least physiologically to highly adverse conditions of existence. What was the nature of the impulse behind this colonization of waters 4 to 5 times as salty as that of the sea? Probably it was the search of new feeding grounds, or may be that these highly saline waters provided shelter from enemies. It will be of great interest to elucidate these interesting biological points.

S. L. H.

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HAFFKINE'S PLAGUE VACCINE. By Lt.-Col. J. Taylor, *Indian Journal of Medical Research Memoirs*, No. 27, 1933.

The above is a review of the extent of success that attended the use of Haffkine's plague vaccine during the past thirty-four years and of which thirty-six million doses have, so far, been issued in India as a measure of personal prophylaxis and for the reduction of high mortality from plague.

The account of Haffkine's discovery reads like a romance. In 1895, Haffkine took up work as the member of a Committee to investigate the origin and nature of plague. Within three months he immunised rabbits against artificial inoculation of a virulent culture of *B. pestis* by previous subcutaneous injection of a sterilised broth culture of the same organism. Subsequent work was merely the extension of the fundamental principle, but Haffkine had to spend a considerable part of his time in convincing medical authorities as well as the lay public of the efficiency of his system of treatment!

In recent years considerable improvement in the methods of obtaining growths of virulent cultures, testing for the potency of the vaccine and efficient bottling have been made. They relate mainly to (1) obtaining seed material from passage animals by the selection of single colonies of culture tested in a reliable manner, (2) standardisation of the chemical composition and the reaction of the broth, (3) reduction in the period of incubation to four weeks, and (4) introduction of a reliable method of final purity testing. The researches leading to the above together with the details of the present method of manufacture have been described by the author and make highly useful reading.

Analysis of the statistics relating to the use of the vaccine in India presents, however, several difficulties chiefly owing to the inadequacy of the records that are available. The results taken as a whole do, however, show in a convincing manner that among the inoculated population not only has the percentage of plague attacks been reduced, but that there has also been a marked decrease in mortality among those who have been inoculated.

The later chapters of the memoir relate to the vaccine and its properties. Experiments have been conducted with a number of animals susceptible to plague to study the properties of the toxin and the best ways of securing a serum with maximum immunising properties. The results have shown that the supernatant liquid is nearly as potent as the whole prophylactic. The vaccine prepared from a virulent culture is very much more potent than the one from a virulent strain. The toxicity of the vaccine is proportional to its potency, a fact which was first noted by Haffkine himself. Studies on the effect of storage have shown that the potency of the vaccine is not greatly effected by keeping even for several months. Researches on the standardisation of the products have shown that methods of plating and counting are generally ineffective. Haffkine's method for measuring the potency of the vaccine is useful but not quantitative. The more recent biological methods depending on the dose required to confer immunity in animals is highly reliable and has now been adopted as a measure of the potency. The methods of manufacture are now so standardised that the vaccine finally obtained is generally of a uniform composition so that further evaluation of potency is generally unnecessary. The use of a strain of high virulence, isolation and preservation of seed material under strictly uniform conditions, the adoption of a medium of fixed composition and reaction and incubation at regular temperature for a fixed period satisfy most of the requirements for obtaining the standard product so that the vaccine as prepared at present is not only uniform in composition and character but also highly potent in its action.

The memoir is a valuable contribution to an important subject and deserves careful study.

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SIR PRAFULLA CHANDRA RAY SEVENTIETH BIRTHDAY COMMEMORATION VOLUME. Pp. v+362+portrait (Special number of the *Journal of the Indian Chemical Society*; Calcutta University Press). Fellows, Rs. 3; non-Fellows, Rs. 5.

It may be presumed that the purpose of a commemoration volume is to signalise the respect and esteem in which the subject of it is held among all his colleagues, who, to this end, are represented by a select body of contributors; and so few persons achieve the distinction proper to such veneration that it should not be difficult to ascertain whether this form of eulogy is the most agreeable to a majority of them. Probably to Sir P. C. Ray, who may be classified as a seagreen incorruptible, it is the most agreeable; but as one of his many admirers I would have greatly preferred an assemblage of impressions produced by the Father of Indian Chemistry in the minds of those numerous collaborators and others with whom, at various times and in various places, he has made ineffaceable contacts.

Stated otherwise, the defect of the present collection of memoirs, as a commemoration volume, is that you bid farewell to Sir P. C. Ray before attaining the first page, the only robust link with him being the delightfully characteristic portrait which adorns the opening. A much more attractive remembrance would have been his recently published autobiography, giving in his own inimitable manner the vivid and enlivening picture of an outstanding personality. As an appendix to this might have been offered the recollections of those who know and esteem him, thus bringing into light all the facets of his versatility, and saving from oblivion a variety of incidents and thumbnail sketches of ancillary figures; these would have reminded us of the sometimes forgotten fact that chemists are human beings.

Having written this in sorrow, not in anger, I have nothing but praise for the wealth of diverse and interesting material here presented. From the first item, appropriately introduced by the President of the Chemical Society, London, throughout until the last, by Dr. Franz Fischer of the Kaiser-Wilhelm Institut für Kohlenforschung, Mulheim-Ruhr, every contribution justifies its inclusion, and the prodigality of subjects recalls the bill-of-fare with which pre-War transatlantic liners were wont to dazzle their less fastidious passengers. A rough analysis of the 36 memoirs apportions their subjects among the following branches:—Physical (8), organic (7), colloidal (5), pyrochemical and biochemical (each 4), molecular (3), photochemical (2), thermodynamic, therapeutic and microchemical (each 1). The fact that only ten originate from countries other than India is no geographical measure of that admiration for the Master of Nitrites—a happy sobriquet due to Professor H. E. Armstrong—which is cherished by chemists. The general production is excellent, and gives evidence of more than ordinary care having been taken to preclude typographical blemish.

Thus the promoters of the volume, and the collaborators who gallantly responded to their invitation, deserve warm congratulation on the success of their enterprise, which is calculated to give the maximum pleasure in the proper quarter. Sir P. C. Ray amply merits this generous tribute. In his person, mind has triumphed over matter. Undeterred by frail physique, he has toiled unflaggingly and courageously in a climatic environment which would have speedily quenched a more indomitable spirit. Even yet the crusader has not sheathed his flashing sword, and the hope that he may long continue his constructive labours will be universal.

M. O. F.

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